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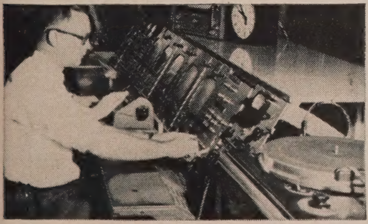

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Bell Labs photo by Dan Rubin

See page 57

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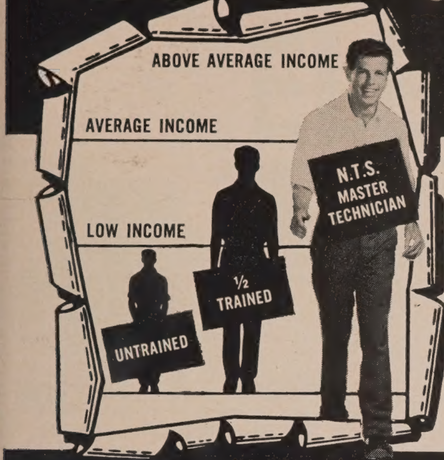

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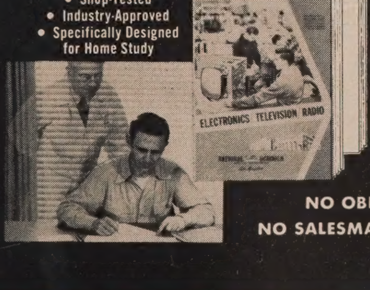

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News Briefs

New Color Tube Is Brighter

Up to 50% greater brightness is claimed for the new RCA color picture tube developed by the Electron Tube Div. at Lancaster, Pa. Improved phosphors of the sulfide type are credited with the new improvement. A better color balance achieved by matching the high-efficiency phosphors, and sharper pictures of rapid-action scenes obtained by shorter phosphor persistence are other features of the tube.

RCA officials point out that the new tube will make color TV practical in public places where high room lighting previously made it impractical, as well as making it easier for dealers to demonstrate in the usually well lighted showroom. The tube is being furnished to manufacturers in either the conventional type which uses a regular safety glass or in the laminated safety-plate type which does not need any additional protection.

TV Pix to Come from Moon

The Surveyor spacecraft, recently ordered from the Hughes Aircraft Co. by the National Aeronautics and Space Administration, will carry no less than four TV cameras to send pictures of the moon's surface back to the earth.

The Surveyor will weigh 2,500 pounds when the Centaur rocket which sends it on its way to the moon falls away. After its retro rocket, which cushions the landing, burns out, it will weigh 750 pounds, of which more than 200 will be scientific equipment. The "soft" moon landing is expected to take place at about 6 miles per hour. Besides the TV instruments, Surveyor will carry a seismometer, magnetometer, gravity-measuring equipment, a drill designed to penetrate the surface to a depth of 5 feet, and instruments to measure radiation and the lunar atmosphere.

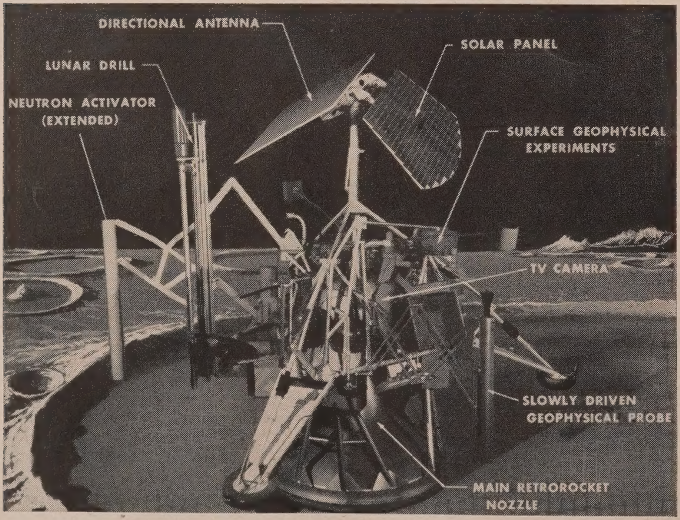
Vhf Translators Start Work

Translators K3AA and K13AA, both at Mexican Hat, Utah, began to repeat the programs of KGGM-TV and KOB-TV, Albuquerque, N. M., about the middle of February. They were the first under the FCC's vhf booster rules. Transmitters were supplied by Blonder-Tongue's Benco Div. Over 900 permits were issued to existing boosters, permitting them to continue in operation while their equipment is modified to meet FCC standards for vhf translators.

Smog Kills Higher Frequencies

Microwave signals over an 11.4-mile line-of-sight path, which came in perfectly on clear days, faded and disappeared on days when temperature-inversion-caused smog prevailed, California engineers discovered. The experiment was set up between the Los Angeles City Hall and the UCLA physics building. Signals at 36,000 mc (36 gigacycles) and higher faded, at times completely, especially when the inversion layer was below 1,000 feet and while the sun was rising.

The practical importance of the work is in setting an upper frequency limit for radio transmission during smoggy weather. Frequencies below 36,000 mc may be considered reliable. A less important result is the discovery that microwaves are a fast method of measuring the height of an inversion layer, especially when between 500 and 1,000 feet.



Artist's idea of the Surveyor in action on the moon.

RCA Makes "Dark Heater" Tube

Development of a new tube that operates at temperatures 20% lower than those necessary with conventional heaters was announced recently by the RCA Electron Tube Div. The new tubes get their name from the gray insulation coating on the heater wire. They operate 350°K below the 1,500 to 1,700° Kelvin of the conventional white heater.

More than a quarter million of the new tubes have been produced to date, and they will be used in a wide variety of receiving tubes within the next few months. They are expected to reduce the effects of ac leakage and hum, cut down the possibility of heater damage and shorts due to changes in heater shape during warming and cooling, and maintain stable current characteristics throughout a "greatly extended tube life."

Lescarboura Honored

Austin C. Lescarboura, one of the pioneers in the electronics and electronic publishing fields, was tendered a testimonial dinner by more than 120 leaders of the electronics industry early this year. The dinner concluded with talks by a dozen of his old associates, and he was presented with a color TV receiver and a silver tray engraved with the signatures of the speakers.

Austin Lescarboura was one of the earliest editors of Gernsback publications, having started in 1910 in Gernsback's Electro Importing Co., shortly thereafter becoming associate editor and later editor of *Modern Electrics*. Continuing with *Modern Electrics* when it left the

Gernsback fold, he remained editor as the magazine took over *Electrician and Mechanics* of Boston and *Popular Electricity* of Chicago, becoming successively *Modern Mechanics*, *The World's Advance*, and *Popular Science*. Resigning at that time, Mr. Lescarboura joined Scientific American, where he remained as associate and later as managing editor till 1924, resigning to engage in freelance writing. The next year he started his own publicity agency, which as a publicity and advertising agency is now under the active managership of his son Stanley.

Lescarboura has written a number of books, best-known of which are *Radio for Everybody* (1921) and *This Thing Called Broadcasting*, written in collaboration with Dr. Alfred N. Goldsmith in 1931.

Among those paying tribute to Lescarboura were Allen B. Du Mont and Hugo Gernsback. Some of the speakers had journeyed some distance to the New York dinner. These included Charles Golenpaul of Aerovox, New Bedford, Mass.; Victor Mucher of Clarostat, Dover, N. H., and Tore Lundahl of Taco, Sherburne, N.Y.

Lady Amateurs Gather

Annual Midwest YL Amateur Convention, sponsored by the Ladies Amateur Radio Klub of Chicago (LARKS), will be held May 19 and 20, at Weller's Motor Lodge, 6450 W. Touhy Ave., Chicago. The FCC has issued the call W9YL for use during the convention. It will operate on all bands with a complete 1-kw SSB station loaned by Hallicrafters.

Microscope Shoots "Live"

An electron microscope developed by Prof. Gaston Dupuoy of the Toulouse Electron Optics Laboratory can be used on living bacteria. Previous instruments, into which the bacteria had to be inserted before the microscope was pumped for each setup, killed the bacteria by drying them out as the tube was pumped out to produce the necessary vacuum.

Professor Dupuoy protects the bacteria by sealing them in an air-filled cell separated from the vacuum by two thin layers of collodion. Since the ordinary 50 kilovolts of an elec-

(*Continued on page* 14)

The Businessman in the Serviceman suit is aware that color TV sales will sky-rocket in 1961*. He realizes *every* color TV owner is a prime *antenna* prospect. That's why he recommends a JFD Hi-Fi TV antenna installation for fidelity color reception as well as best black and white. It delivers the picture that viewers pay for . . . earns him the prestige and profits he is in business for.

*For all 1961 sales of color receivers will top 200,000 units. —Wall Street Journal

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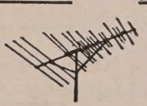

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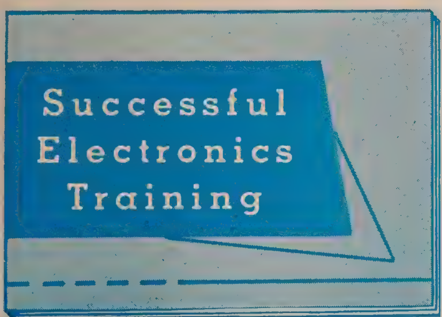

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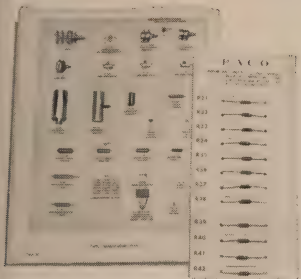
If drug manufacturers made the mistakes in labeling you find in some kits, the world would be a quieter, lonelier place. You know a selenium rectifier when you see one, and if this is a selenium rectifier, you're Thomas Alva Edison.

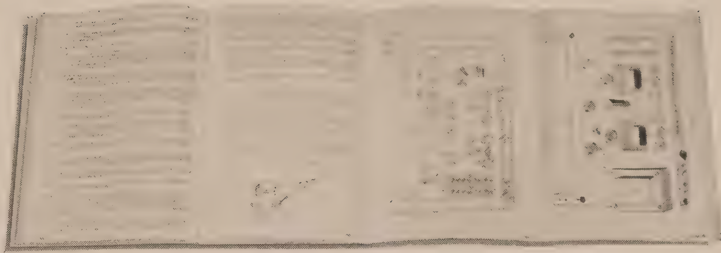
Let's see. On Page 5 it says; "See diagram Page 12." On Page 12 it says; "See instructions Page 5." Well, if you hold Page 5 open with your tongue, and Page 12 open with your left ear, that still leaves you three fingers on your left hand free for soldering and also...

Don't look now, but while Heifetz fiddles, your amplifier burns. When the smoke clears, you'll probably find that the 100 microfarad electrolytic was shorted because it had not been pre-tested. All work and no play, makes Jack a very mad boy!

UNLESS THE KIT YOU BUILD IS A PACO



No mistaken identity or endless searching. Parts are clearly pictured and labeled; resistors are neatly mounted and identified!



Step-by-step instruction book makes assembling a Paco Kit foolproof! Paco gives you giant, fold-out diagrams on corresponding instruction pages so you can see both at the same time.

PACO Model C-25
IN-CIRCUIT CAPACITOR TESTER KIT

Reveals dried out, shorted, or open electrolytics—in the circuit—with Paco's exclusive Capacity Dial. Instantly finds open or direct shorted capacitors without removing from circuit. Great time saver!

Specifications:

SIMPLE SEQUENTIAL TEST: reveals open or shorted capacitors, including electrolytic types.

ELECTROLYTIC DIAL: indicates actual electrolytic values while capacitor is in-circuit; any electrolytic which yields a capacity reading on Electrolytic Dial is automatically revealed as not open or shorted.

ELECTROLYTIC TEST: indicates in-circuit electrolytic capacity from 2 mfd to 400 mfd in two ranges; condenser is automatically proved non-shorted and not open if Capacity Reading can be obtained.

Model C-25: Kit, complete with PACO-detailed assembly-operating manual. **Kit Net Price: $19.95**

Model C-25W: Factory-wired, ready to operate. **Net Price: 29.95**

PACO Model DF-90
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Specifications:

FULLY TRANSISTORIZED: 5 transistors, with a low battery drain for extremely long battery life.

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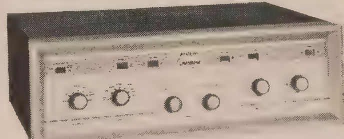
Model DF-90: Kit, complete with PACO-detailed assembly-operating manual. **Kit Net Price: $84.50**

Model DF-90W: Factory-wired, ready to operate. **Net Price: $135.50**



PACO Model SA-40
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Assemble a superb home music system with this true 40 watt stereo preamp-amplifier. Unmatched flexibility, less than 0.5% distortion, and handsome design make this the ideal component for music lover and audiophile alike!

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(Continued from page 8)

tron microscope would be stopped by the two collodion layers added to the thickness of the specimen, Dupuoy shot beams of million-volt electrons in pulses. These made satisfactory pictures without harming the bacteria. The result is pictures of living organisms, rather than those of dried-up husks that were made with the ordinary electron microscope.

Correction

In the item "Electricity Replaces Ether" on page 6 of the March issue, the statement was made that the work took place in the University of Michigan. Actually it took place at the University of Mississippi Medical Center. RADIO-ELECTRONICS regrets this misprint, which was called to our attention by a number of readers.

Zenith Will Make Color TV

Announcing that it will make color TV receivers for the fall market, Zenith says its line will be "completely new and unique." Complete details of the proposed innovations will not be revealed till the sets are on the market, but it is learned that the picture tube will be the new RCA three-gun shadow-mask type (page 6). The color demodulation system will employ a new tube invented by Zenith scientists, however.

Horizontal chassis design and hand-wired circuitry will prevail in the new color sets, Zenith states.

FCC Asks Uhf for All TV's

The Federal Communications Commission proposes Congressional legislation to make all new TV receivers usable on the uhf as well as the vhf band. This, the commission believes, would make the introduction of uhf much easier in areas where uhf stations may be established in the future, as well as improve the situation of uhf stations now operating in areas where there are both vhf and uhf transmitters. The cost of including all-channel coverage in a receiver, Commissioner F. W. Ford estimated, would be about $10 per unit. An added converter to a vhf set usually costs more, plus installation charges and the inconvenience of an additional piece of equipment.

Transistor Hits 5 Gigacycles

A laboratory prototype transistor has been measured at a maximum oscillation frequency of 5,000 megacycles, the Lansdale Div. of Philco reports.

The transistor was an MADT (micro-alloy diffused-base transistor) with a gain of 14 db at 1,000 mc and 21 db at 420 mc, with noise figures of 8 and 4 db, respectively.

The performance of the new transistor is due to careful attention to electrode geometry, according to Dr. C. G. Thornton, Lansdale's director of research and development. He explained that electrodes of approximately 1.5 mils in diameter and a base width of .03 mil have been used. These factors, he said, plus an increase in surface concentration in the region immediately adjacent to the edge of the emitter have permitted a 2-to-1 reduction in the level of high-frequency base resistance.

Calendar of Events

IRE Electronic Components Conference, May 2–4, Jack Tar Hotel, San Francisco, Calif.

IRE Symposium on Human Factors in Electronics, May 4–5, Marriott-Twin Bridges Motor Hotel, Arlington, Va.

IRE Midwest Symposium on Circuit Theory, May 8–9, Allerton Park & Urbana Campus, University of Illinois.

IRE National Aerospace Electronics Conference, May 8–10, Biltmore and Miami hotels, Dayton, Ohio.

IRE-AIEE Western Joint Computer Conference, May 9–11, Ambassador Hotel, Los Angeles, Calif.

IRE Microwave Theory & Techniques Symposium, May 15–17, Sheraton Park Hotel, Washington, D.C.

IRE-AIEE Global Communications Symposium, May 22–24, Hotel Sherman, Chicago, Ill.

IRE-AIEE National Telemetering Conference, May 22–24, Sheraton Towers Hotel, Chicago, Ill.

1961 Electronic Parts Distributor Show, May 22–24, Conrad Hilton Hotel, Chicago, Ill. (Attendance limited to manufacturers and their advertising agencies, representatives and distributors) ***Radio-Electronics*** will exhibit in room 610.

EIA Annual Convention, May 24–26, Pick-Congress Hotel, Chicago, Ill.

British Radio and Electronic Component Manufacturers' Federation Show, May 30–June 2, Olympia, London, England.

Instrument Society of America Conference and Exhibit, June 5–8, Royal York Hotel and Queen Elizabeth Hall, Toronto, Canada.

IRE National Symposium on Radio-Frequency Interference, June 12–13, Sheraton Park Hotel, Washington, D. C.

IRE National Conference on Broadcast & Television Receivers, June 19–20, O'Hare's Inn, Des Plaines, Ill.

Teletype for Your Car

A communication system that types messages received by radio in a moving car or boat has been announced by Goodyear Aircraft Co., Litchfield Park, Ariz. The message is typed on a cigar-box-size teleprinter transmitter in the office (or home) and can be transmitted over a range of about 20 miles. The battery-powered receiver and teleprinter weighs 20 pounds. Speed is 120 letters a minute. The unit was developed for the military, but Goodyear foresees many applications.

FAA Pushes Air Safety

The Federal Aviation Agency has acquired five airplanes to use for monitoring the accuracy of aerial navigation signals, in a semi-automatic flight-check system that will make it possible to make sure in a fraction of the time now required that navigation signals are right.

The planes will be flown on grid patterns while multiple receivers are tuned to ground stations on each side of the path.

The agency also reports a successful test of a new three-dimensional radar unit. Built recently at the agency's research center in Atlantic City, N. J., it is expected to reduce the danger of mid-air collisions. END

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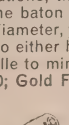

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THAT METER EXPANDER

Dear Editor:

In my article "Make Your Meter Easier to Read" which appeared in the February 1961 issue of RADIO-ELECTRONICS, I described a circuit for expanding the range of ac voltmeters.

A few of your readers have written, some asking for more information about the results to be expected, others stating that the setup could not work.

In the article I stated that the circuit makes it possible to note minute "changes in line voltage" accurately.

When a pair of OB2 V-R tubes are connected in reverse parallel as described in the article, the ac meter is connected across the resistor in series with the V-R tubes. The meter measures the voltage drop across the resistor. This drop is a function of V-R current flow, which rises as the line voltage being measured, and vice versa.

If the current through the resistor were a true sine wave, the voltage drop across the resistor could be measured as an rms value. However, the current is not sinusoidal because the tubes do not fire during their respective cycles until a certain voltage is reached.

Nevertheless, the queer waveform is such that the reading obtained with a rms voltmeter is close to the rms value. Using an Argonne AR-660 vom, I found the line voltage to be 130, the drop across the V-R tubes 105 volts, and the drop across the resistor 25 volts.

Using a vtvm, I got higher readings.

I also looked at the waveform with a Scopes Inc. laboratory-grade oscilloscope and concluded that with a peak-reading voltmeter (vtvm) you should get a too-high reading, but with an rms type conventional voltmeter you should get a reading close to the rms value. The high peaks are offset by the relatively long periods of zero current (when V-R tubes are not conducting). The composite result is a current which is higher than the rms value, but for a period of less than a half-cycle in each direction.

LEO G. SANDS

Ridgewood, N. J.

[RADIO-ELECTRONICS received a large number of letters on the subject, ranging from a flat statement that the OB2 has a reverse voltage of 50 and won't work to ". . . to summarize, the circuit . . . may be used to determine line voltage to a higher degree of accuracy than

offered by the ordinary ac voltmeter. However, the relationship between the voltmeter reading, the regulating voltage of the V-R tube and the ac line voltage is not nearly so simple as Mr. Sands suggests. Furthermore, it is necessary to know the type of ac meter, as well as the exact characteristics of the V-R tubes used."

We found the above statement correct. Mr. Sands' equipment was checked with two sets of OB2's. One set regulated at exactly 105 volts, the other at 95. Varying the voltage with a Variac showed agreement over the normal range of ac voltage variation, when measured with a 20,000-ohms/volt and with a 1,000-ohms/volt meter. The expansion of the scale made it possible to read small changes in voltage easily.

A vtvm gave consistently high readings, and is not suitable for use with this instrument. Deviations from correctness were found as the voltage was raised toward 130 and dropped toward the regulating voltage of the tube. Readings were high in the first case, and low and erratic as the voltage dropped to where the current through the tubes approached zero.

Results indicated that, though the form of the wave departed fantastically from a sine wave, a rectifier type meter measured it accurately and, of course, the spread offered by the expansion made it possible to read the meter much more accurately. It is, however, necessary to calibrate each installation, due to variations in tubes (one correspondent sent in figures based on OB2's that regulated at 108 volts) and meters.]

IMPEDANCE MATCHING

Dear Editor:

I would like to take this opportunity to correct some implications in the March 1961 TV Service Clinic. Concerning the use of signal generators in TV alignment, Mr. Darr states, "If our impedances are matched, we get maximum current flow; therefore we also get maximum voltage drop." This, unfortunately, is not quite the case.

It is true that when the impedances are matched, we deliver to the load impedance the maximum possible *power*, which will be, as Mr. Darr states, one-half the total power in the circuit. The load voltage, on the other hand, will not be maximum when the load impedance is equal to the source impedance; it will instead be exactly one-half the open circuit terminal voltage of the generator.

It is true that the most efficient transfer of power is made when the impedances are matched, but current is neither maximum under these conditions, nor is voltage. Current will be maximum when the load impedance is zero and voltage when the load impedance is infinite.

Second, concerning the proper termination of signal generator cables when

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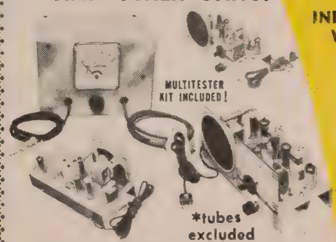

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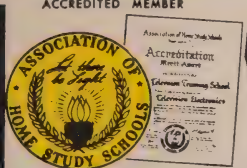

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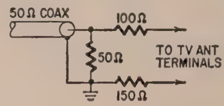
hooking up to a 300-ohm antenna circuit, for example, simply connecting a 50-ohm resistor across the output end of the 50-ohm coaxial line will not terminate the line correctly. Since the generator is supplying rf energy through



an unbalanced coax, and the average TV set input connection is for 300-ohm balanced, this method will create standing waves instead of preventing them. What is required is both an impedance conversion plus a conversion from unbalanced to balanced. A "balun" might be employed here, but a less expensive expedient which will do much the same thing is shown in the diagram.

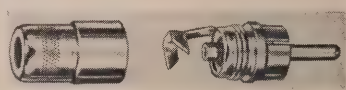
Thank you for your excellent coverage of these important topics. Proper use of terminating resistors usually makes the difference between success and failure in TV alignment.

WILLIAM H. BUSHNELL
Fairfield, Calif.

ABOUT THOSE PHONO PLUGS

Dear Editor:

This letter is about the article, "Easy-To-Connect Audio Plugs", which appeared in the February issue on page 49. It gives credit to one company in particular for a phono plug with a built-in cable clamp. In addition, credits were also given to a certain company for a phono plug developed and manufactured in Great Britain.



For your reference, I have attached a copy of our catalog C-501 which illustrates our 3501MC phono plug with integral cable clamps. Switchcraft pioneered this development. Another of our plugs which should definitely have appeared in your article is Switchcraft type No. 3502. A photo of this phono plug is attached.

CLYDE J. SCHULTZ
Sales Promotion Manager
Switchcraft Inc.
Chicago, Ill.

END

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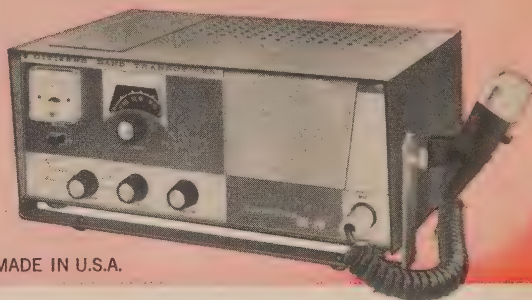

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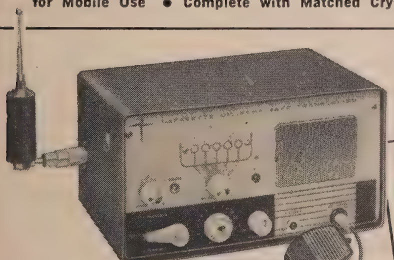

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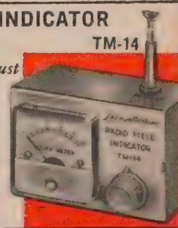

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TVI CAUSES, EFFECTS AND SOLUTIONS, *General Review*, gives the problem detailed coverage by consolidating up-dated material from three previously published books and new information. Many illustrative photos and diagrams. —**Harold R. Richman, Editor, Washington Television Interference Committee,** Television Interference Aids, 1110 Lake Boulevard, Annandale, Va. **Send 9 x 12 self-addressed, stamped envelope.**

ANTENNAS and accessories are topic of *Communications and Citizens Band Products, Catalog FR-61-B.* Indexed booklet gives illustrated descriptive notes, purpose and price of each item. Chart of miscellaneous accessories concludes its 16 pages.—**G C Electronics Co.,** Div. of Textron Electronics, Inc., 400 S. Wyman St., Rockford, Ill.

METALLIZED PAPER CAPACITOR *Catalog 131B8* features types capable of operation to 125°C without voltage derating. Gives complete physical and electrical characteristics and includes temperature characteristics curves and performance characteristics tables along with size charts and case style diagrams. —**Aerovox Corp.,** New Bedford, Mass.

RECTIFIER POWER TRANSFORMERS P-8193 and P-8194 are presented in *Bulletin 587 11-60.* Single page contains specs and full- and half-wave bridge circuits for each.—**Chicago Standard Transformer Corp.,** 3501 W. Addison St., Chicago 18, Ill.

CAPACITOR merchandising program folder. Two-color illustrated brochure mentions *Sportsmen's Delight* kit that includes free fishing lures; and the *Jewel Box* assortment, 45 Mylar-paper gold-dip capacitors encased in plastic cabinet.—**Pyramid Electric Co.,** Distributor Div., Darlington, S. C.

NEEDLE REPLACEMENT *Wall Reference Chart for 1961* lists diamond, jewel or osmium needle by manufacturer's cartridge number and indicates record speed. Illustrates needle replacement.—**Duotone,** Locust St., Keyport, N. J.

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niques, is 12-lesson correspondence course containing up-to-date information on maintenance and repair of automobile, AM/FM, transistor, marine and miscellaneous radios, including foreign-make and short-wave receivers. Write for details.—**Sylvania Electric Products Inc.**, 730 Third Ave., New York 17, N. Y.

ULTRAMINIATURE AUDIO AMPLIFIER measures 0.531 inch in diameter and 0.228 inch high. TA-12-B featured in descriptive bulletin, *42-870*, which details its electrical and physical specifications.—**Centralab**, Electronics Div. of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

RECTIFIER WALL CHARTS, *545-ECG* and *ECG 546*, will assist in selection of optimum silicon and germanium rectifier components for basic circuits on basis of average amperes per cell, recurrent peak reverse voltage and temperature. Color code. Explanatory notes.—**General Electric Co.**, W. Genesee St., Auburn, N. Y.

CAPACITANCE MEASUREMENT is studied in *Aervox Research Worker*, January–March 1960 and April–June 1960 issues. 8 pages, with figures, examine fundamentals of capacitance and discuss four methods for measuring it.—**Aerovox Corp.**, New Bedford, Mass.

AUDIO–STEREO items introduced in 8-page *New Products Catalog FR-61-A*. Among additions to manufacturer's line are album of phono record accessories, volume and speaker controls and complete series of exact replacement record changer knobs.—**Audiotex Mfg. Co.** (Div. of Textron Electronics Inc.), 400 S. Wyman St., Rockford, Ill.

CATHODE-RAY TUBES, ranging from 5- to 24-inch screens are listed in *Bonded Shield*. 8-page booklet highlights design and performance advantages of latest industrial and military cathode-ray tubes in which safety panel is laminated to faceplate.—**Sylvania Electric Products Inc.**, 1100 Main St., Buffalo 9, N. Y.

HOME-STUDY COURSES for individual and industrial training described in *General Catalog 1125N*. The more than 250 courses offered include 25 in electronics, ranging from short course on electronic fundamentals to electrical engineering with special electronics optional section. 11 of the 25 electronics courses are new.—**International Correspondence Courses**, Scranton 15, Pa.

WIRELESS MICROPHONES, FM receivers and radio-controlled relays are the subject of 4-page *Price Sheet 600926*. In addition the catalog contains specifications and a section describing suggested applications in multiple operation.—**Vega Electronics Corp.**, 10781 N. Highway 9, Cupertino, Calif.

CRYSTALS and other precision-made equipment and their accessories are listed in a new 1961 catalog. Description and data, frequency ranges, modes of operations, technical information, some typical circuits and illustrations for almost every item fill its 31 pages.—**International Crystal Mfg. Co., Inc.**, 18 N. Lee, Oklahoma City, Okla. END

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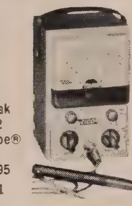
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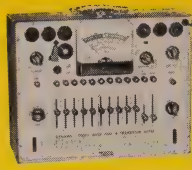
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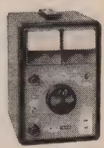
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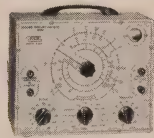
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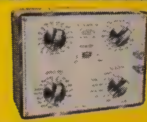
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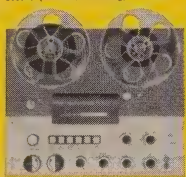
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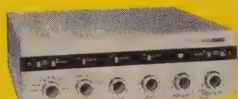
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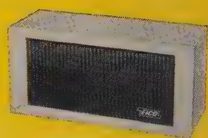
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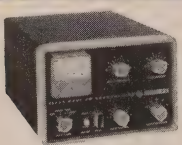
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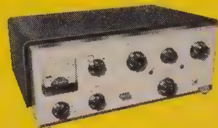
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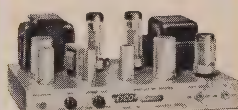
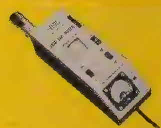
Kit $79.95 Wired $119.95


Universal Modulator Driver #730
Kit $49.95 Wired $79.95
Cover E-5 $4.50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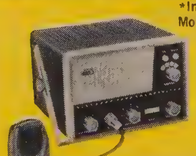
NEW DeLuxe
Citizens Band Transceivers:
#770: 117 VAC—
Kit $69.95 Wired $99.95
#771: 117 VAC & 6 VDC,*
#772: 117 VAC & 12 VDC*—
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INVENTIONS WANTED

. . . Our Armed Forces Call for New Electronics Ideas . . .

IN our May, 1960 issue, we printed a list of electronics ideas wanted by our Armed Forces. Here is the latest list, which contains mostly new requests.

Anyone may submit to the National Inventors Council proposals for basic inventions needed for national defense. Such proposals should be submitted separately, typewritten, if possible. It is advisable that descriptions be complete, including references to the basic principles underlying the invention and a discussion of any experimental work or tests that have been conducted. Advantages of the invention as compared to existing devices or techniques should also be listed. It is not necessary that sketches or drawings be professional.

Keep copies of all items presented and retain one copy that has been notarized with the exact date so you will always have proof of conception for patentability. This is important because your original copy will not be returned by the Government.

Note that the inventions listed here are outlined only sketchily. The Government booklet gives additional information about the *actual background and need* for each invention.

It is suggested that you write for the booklet *Inventions Wanted by the Armed Forces*, December, 1960, issue. Write to: National Inventors Council, US Department of Commerce, Washington 25, D.C. —*H.G.*

ELECTRONIC COMPONENTS AND SYSTEMS

1411. LOW-ENERGY, RELIABLE SWITCHING DEVICE.—Develop a low-energy switching device (5,000 ergs maximum) capable of at least 100 reliable operations.

1412. SEMIFLEXIBLE WAVEGUIDE.—Develop a semiflexible waveguide in half-wave size for use in missile fuzing applications.

1413. HIGH-FREQUENCY TRANSISTORS.—Develop inexpensive high-frequency transistors (200 to 500 mc) that can handle 1 to 10 watts of power, and also develop transistors for frequencies between 50 and 100 kc that can handle 100 watts of power.

1437. RELIABLE THERMISTORS.—Produce a line of reliable thermistors that will provide a wide range of temperature coefficients and that will have highly repeatable characteristics.

1438. MICROMINIATURIZATION.—Vast amounts of work are being done in this field, especially in electronic components and subassemblies. Typical is the recently developed evaporative film technique.

1439. LOW-VOLTAGE VACUUM TUBES.—Develop a vacuum tube or other device that will operate on transistor low-voltage power supplies, and will ease the problem of using transistor circuitry to process high-impedance source voltages in control systems. This device shall be capable of eliminating unwanted feedback paths and shall have overall stability, small size, light weight and minimum power consumption.

1441. FAILURE ANALYSIS OF ELECTRONIC COMPONENTS.—Determine shock and vibration characteristics (test to failure) of electronic components, as mounted by conventional techniques utilizing a conventional chassis, to evolve the actual reasons for failure of components.

1456. FLASH X-RAY DEVICE.—Develop a 1-megavolt flash X-ray device with an extremely rugged or expendable power source of small size. The device should provide up to 10 flashes of 0.1- to 1-μsec duration in an arbitrary but accurately timed sequence.

1491. DISTINCTIVE AUDIO SIGNAL DEVICE.—A device capable of producing a sound completely distinctive from present sirens, horns, whistles, bells, buzzers, engines (jet and reciprocating) or explosions. For a size and cost comparable to conventional sirens, the device should produce this sound at not less than 125 db (reference .0002 dyne per cm^2) at 100 feet.

1494. SOLID-STATE HIGH-IMPEDANCE AMPLIFIER.—There is need for a solid-state amplifier with very high input-impedance characteristics (on the order of 10^{11} ohms) and very-low-level noise characteristics, as a replacement for electrometer tubes in conventional ion-chamber detector radiation survey meters. Amplification of ion currents of the order of 10^{-11} amperes is required for metering circuits requiring 50 μa.

LIGHT AND INFRARED

1375. LIGHT SOURCE.—A lightweight high-energy repetitive light source for night aerial photography.

1415. INFRARED FUZE MODULATOR.—Develop an electrical or magnetic modulator (shutter) for IR fuzes.

1435. LIGHT-REFLECTIVE MATERIAL.—Develop a material highly reflective to the light spectrum from infrared to ultraviolet, but transparent to radio-frequency radiation.

RADAR, TRACKING, TV

1374. V/H SENSOR.—A lightweight small-size device for detecting the ratio of velocity with respect to height of a flying vehicle with an accuracy of 0.1 of 1% or better.

1418. MISSILE-TARGET ATTITUDE SENSING SYSTEMS.—Develop an inexpensive, lightweight testing device which gives, in addition to target miss distance, the relative attitudes of missile and target at intercept and fuze firing. The system is to be contained in drone targets and must be capable of transmitting the required information to the ground or recording it for future analysis after the target drone is eventually recovered.

MISCELLANEOUS

1378. PATTERN RECOGNITION.—To develop techniques for electronically simulating human perception processes of judgment, observation and environment, in the recognition of patterns and symbols (Bionics).

1444. ERASABLE, MAGNETIC TAPE.—Develop an erasable, magnetic tape unit which provides an information storage density of at least 10^{12} bits per cubic foot (random access not necessary).

1449. CONVERSION OF HEAT ENERGY INTO ELECTRICAL ENERGY.—Develop an efficient device for direct conversion of heat to electricity. The output should exceed 5,000 watt-hours per pound of device weight.

AVIATION AND MISSILES

1383. ACOUSTICAL TEMPERATURE SENSOR FOR ROCKET SOUNDINGS. A need exists for a sensitive and rugged acoustical temperature sensor for application in meteorological rocket payloads. The temperatures to which the sensor would be exposed range from —60°C to+60°C. The device must withstand 50G acceleration and nose cone temperatures up to 150°C. The sensor would be expelled from the nose cone at apogee (250,000 feet) and would be lowered by parachute. The sensor would be required to operate with plus or minus 5% accuracy from 250,000 feet to 75,000 feet. The sensor and telemetry system should cost no more than $250,000 per unit in lots of one hundred due to the cost restrictions on synoptic rocket soundings from several launch sites.

COMPUTERS AND DATA SYSTEMS

1379. LOW-SPEED FIELDATA PRINTER.—To develop a low-speed fieldata page printer which is lightweight and small (pocket size), utilizing new principles for printing and other electromechanical functions. This unit must be very simple.

1442. ANALOG-TO-DIGITAL CONVERTER.—To process large volumes of data of all types, an analog-to-digital converter is required that is capable of converting all types of analog data (readings of voltage, current, pressure, intensity, velocity, acceleration, and so on) into digital format for magnetic tape storage without any intermediate manual steps such as reading amplitudes visually, tabulating values or plotting curves.

1443. COMPUTER. In the computer field there is a need to: (1) Develop a self-organizing computer which can perform functions analogous to human thinking; (2) Develop a technique which will obviate the propagation time restriction in fast computer designs; (3) Establish in basic computer philosophy the parameters for the optimum computer and formulate a method for determining the most efficient system configuration for a given application.

1445. AUTOMATIC TRANSFER OF ORAL OR HANDWRITTEN INFORMATION INTO DIGITAL INFORMATION SIGNALS.—Develop a mechanism to transfer automatically oral or handwritten information into digital information signals. These signals should be of such a configuration that they may conveniently be recorded on punched or magnetic tape or punched cards.

1446. COMPUTER MEMORY DEVICE.—Develop a random-access computer memory device with a .01-μsec access time, a 10,000,000-bit capacity, and a volume of less than 1 cubic foot.

1460. DIGITAL OUTPUT TRANSDUCERS.—Develop transducers for use on rocket-engine test stands that have digital rather than analog output.

TESTS AND MEASUREMENTS

1320. (Revised) IMPACT ACCELERATION MEASURING AND RECORDING DEVICE.—A device for measuring and recording high accelerations inherent with missile impact. The device should be self-contained in the missile and recoverable. It should be capable of recording the complete deceleration-time curve during impact.

1380. NUCLEAR SURVEILLANCE DEVICE.—Methods for obtaining three-dimensional location and yield of all nuclear detonations to ranges beyond line of sight, under all weather conditions. The method or methods proposed should combine

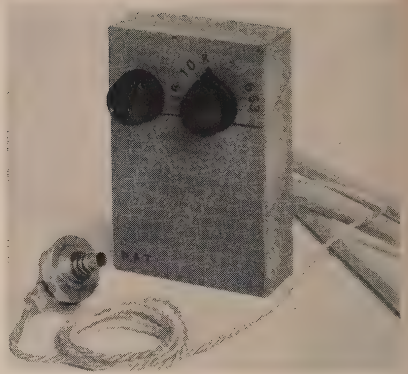
(*Continued on P.* 110)

"Inventions Wanted" has appeared once a year in this space since 1957 in an effort to serve our Government as well as our readers.

We would appreciate a vote from you, on a postcard please, if we should continue "Inventions Wanted" in the future.

The Editors

4-transistor set is a true cigarette-pack sized radio. Printed circuit speeds construction.



FLIP-TOP RADIO

By NICHOLAS A. TAX

THIS four-transistor receiver uses a regenerative detector and three audio amplifiers to drive an earphone. It fits into a box from a pack of cigarettes. Sensitivity is high and no external antenna or ground is needed. A printed-circuit board is available to simplify construction. The transistors are reasonably priced and keep the total cost down.

The circuit is comparatively simple. The AO-1 works well as a regenerative detector. Other transistors were tried, but the AO-1 gave the best results. You may note that its collector load resistor (R2) seems high (100,000 ohms), but lower values reduce volume and selectivity.

Chassis assembly

A printed-circuit board makes this unit easy to build. If you don't care to use one, you will need some stiff cardboard approximately 1/16 inch thick to make the chassis. From this cut two pieces ⅞ x 3-1/32, then two pieces ⅞ x 1-29/32 inches. Cement these together to form a rectangle. Place the two short pieces on the inside so that the outer dimensions of the rectangle are 3-1/32 x 2-1/32 inches. This will form the chassis of the radio (around which we wind our antenna and tickler coils). Next cut a piece of cardboard 1-29/32 x 1⅛ inches (A in Fig. 2). Cement this piece inside the chassis 1/16 inch from the outer edge and at one end (Fig. 2). Then cut a piece of cardboard in the shape of a T (see drawing for dimensions) and cut the holes for the transistor sockets. Sockets are not needed with the printed circuit; the leads are simply soldered to the printed wiring (if desired, sockets can be used). Cement this piece inside the rectangle.

Place some Duco or similar cement in a small container and thin it down to a paintlike consistency with lacquer thinner or nail-polish remover. Then use a small paint brush to give the entire chassis two coats of this mixture (let the first coat dry about 30 minutes). This moistureproofs and stiffens the cardboard.

After the chassis is thoroughly dry, lock the sockets in the holes with the small clips furnished. Next cut the three holes needed for C2 on piece A. Mount C2, using two small screws supplied. Make a single hole on the other side of A in line with the capacitor-shaft hole. Mount the potentiometer with its lock washer and nut. There is enough space above the pot for the two electrolytic capacitors (C4 and C5). The capacitor and potentiometer shafts may have to be shortened so the knobs can be installed.

Battery holders

Get a scrap of 1/16-inch Bakelite or other insulating material. Cut two pieces 1-3/16 inches long and 13/16 inch wide. You now need a scrap piece of 25-gauge stainless steel, copper or brass (shim stock will do). If you use the latter, tin it with solder to prevent corrosion. Make eight L-shape clips (see drawing for dimensions). Place four of them on a piece of lumber and give each one a sharp blow with an ⅛-inch center punch to make a round dent in the metal (to hold the positive end of the battery firmly). Then, rivet the clips to the Bakelite. Small rivets were not readily available, so I used screen wire tacks.

Arrange four clips on each piece, spaced so the batteries will fit in firmly. The heads of the rivets were ground down somewhat so that the underside of the holder will be fairly smooth. Cut the rivets so that about 1/32 inch is left to flatten out. I used a very small ball peen hammer to do this. Stainless steel is relatively hard to drill, so use a center punch to make the hole, and smooth off the underside with a file. Then ream out the hole with a 1/16-inch drill bit.

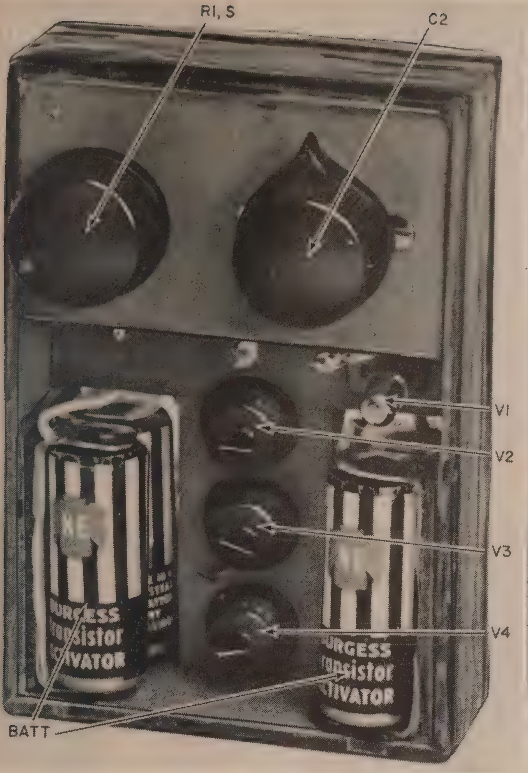
Make sure that the width across the batteries in each holder is less than ⅞ inch (the width of the chassis) so that they will slide into the cigarette box easily. Use *acid*-core solder to tin a small spot on the outer side of each battery clip. Rosin-core solder will not stick to stainless steel. *Wipe or wash these spots off well because acid and radio parts just do not go together.* Now you can solder the wires to the clips with rosin-core solder. The next step is to cement the two battery holders to the inside of the chassis, one on each side. I cemented a piece of paper on each holder to indicate battery polarity for proper battery installation.

Wind the antenna

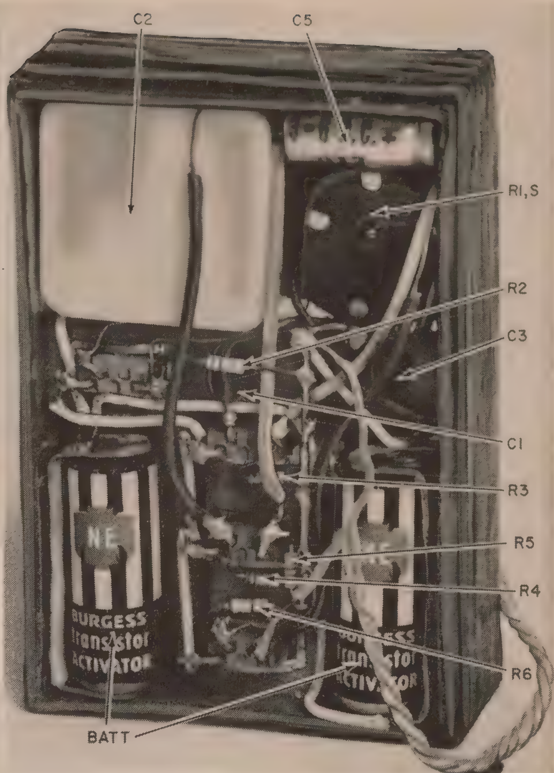
The antenna and tickler coils are wound around the ⅞-inch surface of the chassis with No. 30 enameled magnet wire. Make three small holes about 1/32 inch from the edge of the chassis by pushing a needle through the cardboard. Anchor the end of the wire through the holes, the free end extending inside the chassis. Leave about 3 inches to connect to the antenna terminal of the tuning capacitor. This will be the start of the winding.

Measure off 39 feet 9½ inches of wire beforehand and wind the 46-turn antenna coil, making sure that the windings are as close together as possible. Run the finish of the winding through the chassis (as before) and connect it to the ground terminal of the tuning capacitor. The tickler winding is 9 feet 7½ inches (11 turns). Wind it in the same direction and use the same size wire. Space the tickler coil ⅛ inch from the antenna winding, the start lead (TS in Fig. 1) going to the center terminal and the finish lead (TF) going to the left-hand terminal of the potentiometer (shaft facing you and terminals down).

Once again RADIO-ELECTRONICS is pleased to be able to offer its readers a printed-circuit board for an interesting construction project. The price is $1.25 each, postpaid. They are available from Detroit Electronic Corp., 13000 Capital Avenue, Oak Park, Mich.



Inside the case, looking at the transistor side of the chassis.



Parts layout under the chassis.

R1—pot, 10,000 ohms, with spst switch (Lafayette VC-28 or Philmore PC-53 or equivalent)
R2, R6—100,000 ohms, 1/10 watt, 10%
R3, R5—3,300 ohms, 1/10 watt, 10%
R4—120,000 ohms, 1/10 watt, 10%
C1, C3—.02 uf, 50 volts, ceramic
C2—10—365 $\mu\mu f$, variable (Lafayette MS-274 or equivalent) (For printed-circuit unit: Calrad CR-220, Lafayette MS-445 or equivalent)
C4, C5—3 μf, 6 volts, miniature electrolytic
BATT—6 volts, four 1.5-volt NE cells (For printed-circuit unit; 7-volts, Mallory TR-175 or equivalent)
L1—see text
L2—see text
V1—AO-1 (Philco)
V2, V3, V4—2N107
Earphone, 1,500 ohms
Transistor sockets (4)
Wire, No. 30 enameled, 1/4-lb roll
Miscellaneous hardware

When the coils are finished, give them a thin coat of hot paraffin to keep out moisture and secure them nicely.

BENCH TESTED

The TAX radio was tested about 20 miles from New York City. Nine stations were received with ample earphone volume and good quality, and more could no doubt have been received with careful tuning. The loudest station, about 7 miles away, came in with sufficient volume to permit two persons to listen, with the earphone in a small dish on the table between them.

It is important to have the correct amount of wire in the tickler winding. If the set does not oscillate (hissing or rushing noise) at the low end of the dial, add a few more turns of wire.

I noted a slight variation among some of the AO-1 transistors. One required about four turns more in the tickler winding so the set would oscillate at all points on the dial. If this happens to you, add these turns even if it is necessary to alter the spacing between the coils (1/8 to 3/32 inch). If the set will not oscillate at all, you have probably reversed the leads to the potentiometer.

If your set motorboats when completed, add a stabilizing resistor from the positive end of the battery to V3's base. Start with about 2,700 ohms and work your way down.

Now wire the set, following the schematic (Fig. 1), or use the special RADIO-ELECTRONICS printed-circuit

The printed-circuit board with all components mounted. Only the antenna still has to be connected.

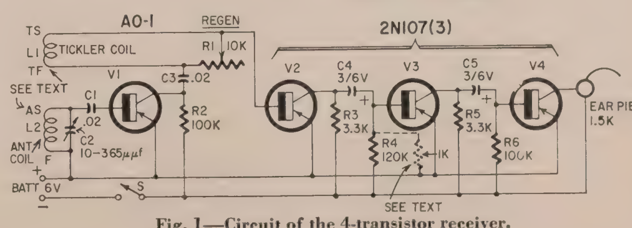


Fig. 1—Circuit of the 4-transistor receiver.

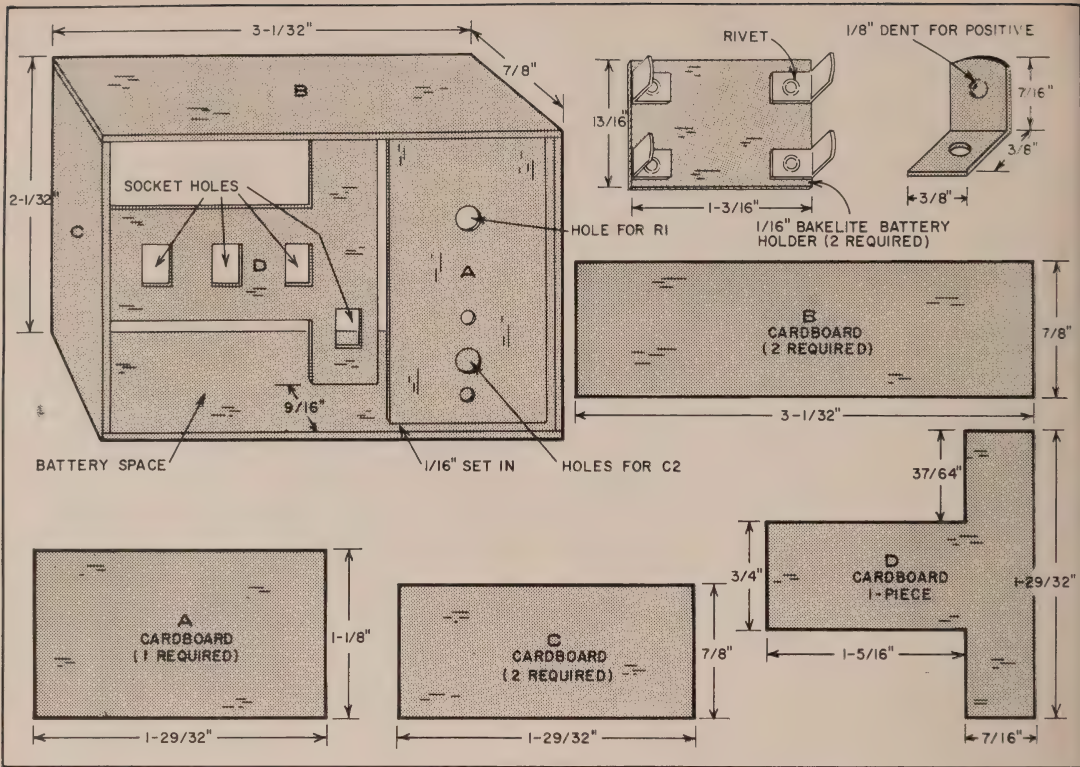


Fig. 2—Chassis assembly for the flip-top radio. If you use the printed-circuit board, only parts C and B are needed.

board. I used a piece of tinned copper wire as a negative bus. Solder it to one side of the switch and run it along the transistor sockets. I used 1/10-watt resistors; there would not have been space for ½-watt units.

The case

Select a cigarette flip-top box in good condition. Take a razor blade and carefully cut off the top where it hinges. Now make two slots in the top and two in the higher part of the box, so the chassis can be slid into the box and the top can be placed back on. Cut the slots wide enough to allow the tuning capacitor and potentiometer slots, and the case looks neat.

Now treat the cardboard box as you did the chassis (two coats of the thinned mixture, inside and out). When thoroughly dry, give the case two coats of shafts to fit. The knobs will hide the your favorite-color enamel. Let the case dry for a few days before inserting the chassis. The box lips should be steel-wooled or sanded lightly to allow the top to slip on and off more easily (the freshly painted surface has a tendency to be a little tight). The chassis can be removed easily by grasping the two knobs and pulling upward.

To give the set a little added touch, calibrate the dial. The tuning-capacitor knob has a pointer on it. After some experience, you will know where the various stations in your locale come in and the dial can be calibrated. I have marked my set 16, 10, 8, 7, 6 and 53. These numbers can be put on by using a toy printing or rubber-stamp set. Hold each number with tweezers and press it against a piece of glass that has a light coat of wet paint. Then press the piece of type to the case.

My set is very selective and will tune the entire broadcast band. Late at night, I have received stations 400 miles away and three stations some 1,500 miles distant. It is well established that regenerative receivers are distance getters. But, as with all regenerative sets, careful adjustments of both controls is absolutely essential. If the regeneration control is turned up too high, the set oscillates and reception is spoiled. On my set, the local stations can be heard with the earphone 6 feet away. Battery drain is low, so batteries last a long time. END

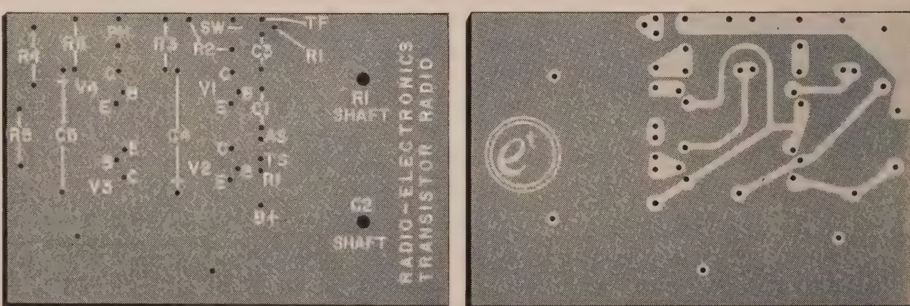
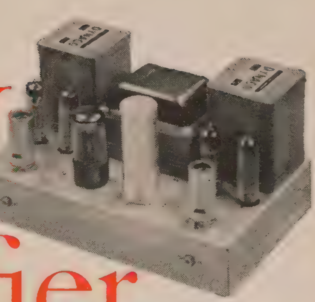


Fig. 3 — The printed-circuit board; left—component side; right—wiring side.

By EDWARD A. LAURENT

Quality Stereo amplifier



A dual (stereo) 20-watt power amplifier with no compromise. The project was started with rigid specifications; and the completed amplifier meets them all. Frequency response is within ±1 db from 10 to 40,000 cycles, or one octave above or below the audio range. You can build it yourself.

WHY RESPONSE BEYOND THE AUDIO range? Because how an amplifier performs beyond the audio range definitely affects what is actually heard. For an amplifier to reproduce a 10,000-cycle square wave faithfully, it must be capable of handling frequencies uniformly beyond audible limits; hence the apparent extremes in freqeuncy response. Incidentally, this indicates why examining the square-wave performance of an amplifier is an excellent way to measure its merit as a high-fidelity instrument. If I were able to make only one test, this is the one I would use.

Another yardstick is to measure intermodulation distortion. Simply, this measures undesirable products generated within the amplifier itself as a result of two or more signal frequencies beating against one another. The IM of this amplifier is less than 1% at its full power output. This means that even at relatively high *listening* levels the distortion will be on the order of 0.25%.

Still another indication of amplifier performance is the measurement of harmonic distortion generated within that amplifier. Within 1 db of rated output of the unit, harmonic distortion at 20 cycles measured 0.6%, at 2,000 cycles 0.3%, and at 20,000 cycles 2%. Frequency response at full power is within 1 db from 15 to 30,000 cycles, and hum and noise are less than 1 mv measured across a 16-ohm load, or 90 db down from rated output.

The only limiting factor in the project was the actual power rating of the amplifier, which is 20 watts per channel. Although this appears to be on the scant side, the total power of the two channels (40 watts) is enough for good home reproduction since it represents more power than is now being used in many excellent monophonic systems. And, in this unit, the full 20 watts of each channel is available from 20 to 20,000 cycles.

The extremely simple circuit (Fig. 2) uses the RCA 7199, designed expressly for this application. It is actually two tubes in one: a pentode and a triode in the same envelope—all that is needed for voltage amplification and phase inversion. The pentode, used as the voltage amplifier, provides all the gain necessary with ample margin for maximum usable negative feedback. The voltage amplifier is direct-coupled to the triode phase inverter to keep phase-shifting stages at a minimum. The R-C network at the plate of the pentode limits the upper bandpass of the earlier stages of the amplifier and avoids excessive phase shift at very high frequencies in the feedback loop. This eliminates stability problems likely to arise in this type of amplifier.

Negative feedback is taken from the secondary of the output transformer to

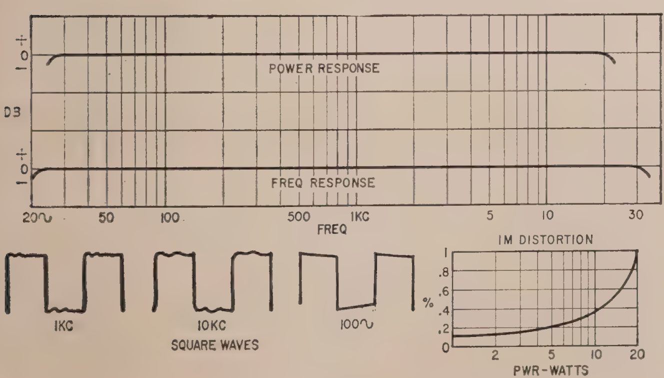


Fig. 1—Characteristics of the stereo amplifier.

the cathode of the input pentode. The triode cathodyne, or split-load inverter, is known for stability, balance and non-critical operation. Unlike several other popular inverters, its performance does not deteriorate with tube age. The circuit values have been chosen specifically for the available supply voltage and, because the circuit can handle much larger signals than required, it has the advantage of coasting along in the unmeasurable distortion range. Although the circuitry is not new, its use in audio has been popularized only in the last 2 or 3 years. Low initial cost, simplicity, stability and sensitivity are all virtues of this arrangement.

Output stage

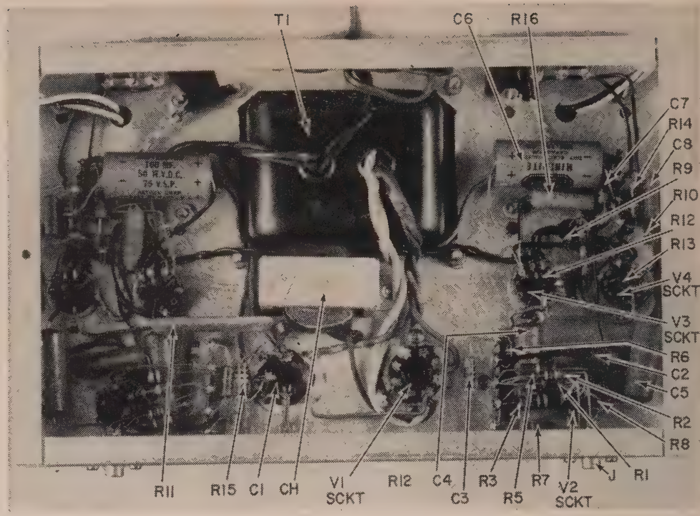
The 7189 output tubes are a fairly recent development. They produce a surprising power output for their size and power supply requirements. High power sensitivity, low inherent distortion and low cost are other desirable factors.

Choice of output transformers can make or break an amplifier design. Wide-band power-handling capabilities, excellent supersonic characteristics plus quality construction are among the reasons for making the Dynaco A-410 my choice.

Although the transformer has taps on its primary (for screen-loaded operation), they were not used in this amplifier. Tests showed no advantage in connecting the taps to the screen grids, but there is an actual power loss if the screen taps are used in this way. Apparently, this tube type works best as a pentode. One tap, however, did prove useful as a feedback point, which helped to establish the unit's excellent margin of stability. The screen grids were supplied with dc through a series dropping resistor to keep them within their dissipation rating.

Cathode bias is a matter of choice. Fixed bias would have resulted in a few more available output watts, but is more expensive and more difficult to set. Self-bias, on the other hand, is self-regulating, requires no adjustment or maintenance and is more faithful as tubes age.

The cathode resistor is bypassed for



A look under the chassis. Only the components in one channel are pointed out.

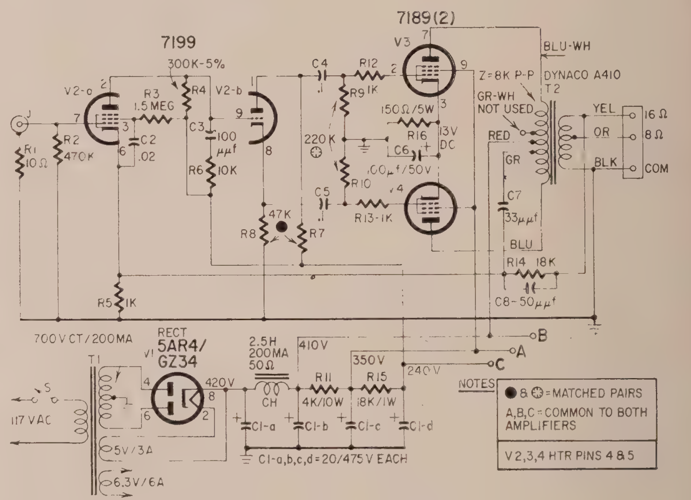


Fig. 2—Circuit of one channel of the stereo amplifier.

BENCH TESTED

Below are the measured specifications for the Laurent amplifier described in this article. Fig. 1 shows them graphically.

Frequency response: ±0.5 db from 25 to 25,000 cycles at 20 watts. 20 to 35,000 cycles at 1 watt.

Intermodulation distortion: (60 and 6,000 cycles mixed 4 to 1)

23 watts	1%
20 watts	0.57%
10 watts	0.25%
5 watts	0.1%

Noise: 0.9 mv across 16 ohms (86 db below 20 watts)

Gain: 0.94 volt input for 20 watts output

Square waves: slight rounding of leading edge first appears at 10,000 cycles. Total ringing about 5%. Slight phase shift starts to show below 100 cycles. Does not break into oscillation with any value of capacitive loading.

Power: 20 watts per channel.

R1—10 ohms
R2—470,000 ohms
R3—1.5 megohms
R4—300,000 ohms, 5%
R5, R12, R13—1,000 ohms
R6—10,000 ohms
R7, R8—47,000 ohms (matched within 1%)
R9, R10—220,000 ohms (matched within 1%)
*R11—4,000 ohms, 10 watts
R14—18,000 ohms
*R15—18,000 ohms, 1 watt
R16—150 ohms, 5 watts
All resistors ½-watt 10% unless noted
*C1—20-20-20-20 μf, 475 volts, can type electrolytic (Sprague TVL-4834, C-D D0179.5, Mallory FP475)
C2—.02 μf, molded
C3—100 μμf, tubular ceramic
C4, C5—0.1 μf, molded
C6—100 μf, 50 volts, electrolytic
C7—33 μμf, tubular ceramic
C8—50 μμf, tubular ceramic
*CH—2.5 henries, 200 ma, 50 ohms (Merit C2974 or equivalent)
J—phono jack
*S—spst toggle
*T1—power transformer: primary, 117 volts; secondary, 700 volts, ct, 200 ma.; 5 volts, 3 amps; 6.3 volts, 6 amps (Thordarson 22R07 or equivalent)
T2—output transformer, Dynaco A410
*V1—5AR4
V2—7199
V3, V4—7189
Chassis to suit
Miscellaneous hardware
*Only one of each of these components is necessary. For a stereo amplifier, two of all other components are needed to build the amplifiers for the two channels.

all frequencies. Observe that here a single resistor could be used for all four output tubes. However, a separate one for each channel insures independent operation of the stereo channels without transient disturbances being reflected from one side to the other.

Power supply

The power supply for a stereo amplifier requires special attention too. An improperly designed supply that allows excessive cross-talk and interaction between the channels defeats stereo performance. In this unit the rectifier is selected for low impedance and husky current rating so a heavy current demand by one channel will not cause a drop in supply voltage and be reflected into the other channel. A choke is used where a resistor might have served, for the same reason. Considerable filter capacitance is used to avoid interchannel coupling.

The charts in Fig. 1 give a picture of the amplifier's performance. Frequency response, square waves and intermodulation distortion are all yardsticks by which an amplifier can be measured; and a critical listening test tells the final tale. You will find this unit meets all the requirements demanded by a "golden" ear.

Now build it

Construction offers no problems. There are no overly critical points in the wiring process. Simple point-to-point wiring should be followed, keeping high-impedance portions of the circuit away from ac fields. A larger chassis may be used for ease of construction. Heater wires should be twisted pairs. When heater leads must cross or come near other components, they should do so at right angles where possible. The power transformer is mounted for minimum effect on the output transformers. Notice that the input jacks are insulated from the chassis. Although not essential for the operation of the amplifier, the isolation of the signal grounds with 10-ohm resistors reduces the possibility of ground loops in your stereo system. It is common practice to use an unused pin on the output sockets to mount the 1,000-ohm grid stopper resistors. *This must not be done with 7189 output tubes as there are internal connections to the apparently unused pins.*

If you are not ready for a stereo system, this unit will make an excellent 40-watt monophonic amplifier. Simply parallel the inputs and outputs of amplifiers. The only limitation is that paralleling the 16-ohm taps limits the unit to a maximum of 8 ohms output impedance.

The sensitivity of the unit—0.94 volt input for 20 watts output—makes it compatible with just about any preamp. The amplifier generates some heat, as do all power amplifiers, and therefore should have ample ventilation. Good components and careful construction will provide you with an amplifier capable of long service and which is a "sound" foundation for your stereo system. END

Part II—Another transistor tuner. This one by Standard Coil.

Transistor Tuners for TV

What makes them tick?

By E. D. LUCAS, JR.

Fig. 1 shows the circuit of the new Standard tuner being produced for Motorola and other TV receivers. Signal from the antenna comes through a 75-ohm unbalanced input, passes through two if traps (outlined by dashed lines) and then through an FM trap (C2, L7 tunable). This input circuit keeps cross-modulation to a minimum. Also, a good match is provided between the antenna impedance and the input impedance of the rf amplifier. In this tuner, the VSWR is maintained at less than 2 to 1 on all channels.

Note that the common-emitter rf stage is operated with forward agc applied from the 13-volt source through a potentiometer. The 1,200-ohm series collector resistor, R4, drops the collector voltage as the collector current is increased. An increase in base or forward bias causes an increase in the collector current. Now, as previously noted, the collector voltage decreases, and there is a decrease in the gain of the rf amplifier. An advantage of forward agc action as compared to negative agc, the technique of reducing collector current by reducing base bias, is that the forward or positive agc method results in a smaller change of input impedance with applied agc voltage. As a result, the impedance match between antenna and transistor input is better and the VSWR is improved over the entire vhf range. Also, the input signal is less subject to cross-modulation at reduced gain levels.

In the Standard tuner shown in Fig. 1, two capacitors, C5 and C6 (a feedthrough type), provide out-of-phase feedback to neutralize the rf amplifier. Fixed values of neutralization capacitances can be used because the variable transistor capacitances are swamped out by the relatively high circuit capacitances.

Conventional coupling between L2 and L3 feeds the rf output to the mixer coil, and trimmer C11 is adjusted to tune the input circuit of the mixer. Notice that this stage has a common-base design as contrasted with the common-emitter mixer of the Sickles Mark 6T we saw last month.

The common-base configuration is also used in the oscillator circuit, which includes a small capacitor, C19, between collector and emitter to assure stable oscillation. Special care has been taken by the design engineers not to load the oscillator output to such an extent that oscillation is not sustained. To maintain oscillation, the collector output is connected to the mixer by the small capacitor, C18. Oscillator frequency is obtained in a manner similar to tube type tuners, with the tunable individual oscillator coil for each channel, L4, paralleled by another variable coil, L10, for fine tuning. L10 has somewhat greater inductance than L4, which may be slug-adjusted from the front.

This oscillator is designed to provide an injection voltage of 150 to 500 mv across the 60-$\mu\mu$f matching capacitor, C13, in the emitter (input) circuit of the mixer. Injection voltages in the range cited appear to provide maximum conversion gain.

The common-base mixer converts the rf signal from the rf amplifier to a 45-mc if. This mixer is designed to drive, from its collector output, the if load impedance consisting of a 50-ohm resistor in parallel with an adjustable pi network. Regeneration, gain and loading are controlled by the output tank circuit, including variable inductor L9 and feedthrough capacitor C17 (8.2 $\mu\mu$f). Since the value of C17 will partially determine the oscillation threshold of the mixer, it is considered critical. This capacitor also swamps out variations in the mixer's output capacitance.

In one of their earlier transistor tuner designs, Standard engineers experimented with common-base rf am-

plifier designs. This approach proved to have certain disadvantages compared to the common-emitter configuration now used. Common-base input resistance increased from about 25 ohms for channel 2 to 135 ohms at channel 13—an impedance change of more than 5 to 1. Meanwhile, the output resistance of the MADT transistor sloped off from 8,000 ohms at channel 2 to 4,000 ohms at channel 13. In addition, the reactive portions of the input and output impedances were naturally also dependent on frequency. Both the resistive and reactive components of these impedances were functions of the operating point or bias of the transistor. As a result, the impedance changes required considerable compensation in the design of both the input network to the rf amplifier and the interstage network between it and the mixer.

While the common-emitter rf amplifier presents a problem in changing input impedance with frequency, it is less severe since the change is from only 135 ohms at channel 2 to 60 ohms at channel 13 in a typical design—in contrast to the 5-to-1 variance of the common-base amplifier. Another advantage is that this input impedance falls off with frequency, as does the output impedance of the grounded-emitter connection. Here again there is a relatively small change in impedance, with the output resistance of the grounded-emitter amplifier changing from approximately 3,000 ohms at channel 2 to 1,200 ohms at channel 13.

A further reason for using the common emitter is that the common-base circuit tends to become regenerative because the emitter and collector voltages are nearly in phase. Inserting a small external capacitance between collector and emitter may cause the rf amplifier to become an oscillator—the technique used in the common-base local oscillator of Fig. 1. This regeneration can be partially controlled by selecting a suitable collector load but internal capacitance, emitter to collector, may be high enough in some transistors to cause undesired oscillation. By contrast, in the common-emitter rf amplifier the input signal is relatively out of phase with the output signal and we get internal negative feedback. As a result, this type of amplifier has inherent degeneration, so most circuit designers using the common-emitter configuration use neutralization to inhibit degeneration.

Typical performance characteristics of the current Standard transistor tuner are presented in Fig. 2. Gain figures are very good indeed, ranging from 41 db at channel 2 to 23 db at channel 13, while the noise figures are consistently good, from 6 to 8.5 db. In this tuner, a 13-volt negative supply was used and the maximum gain appeared at an agc voltage of −0.8. The fine-tuning range is 5–6 mc and such characteristics as if and image rejection, VSWR and maximum gain reduction (using forward agc) are entirely satisfactory.

This transistor tuner can be used for

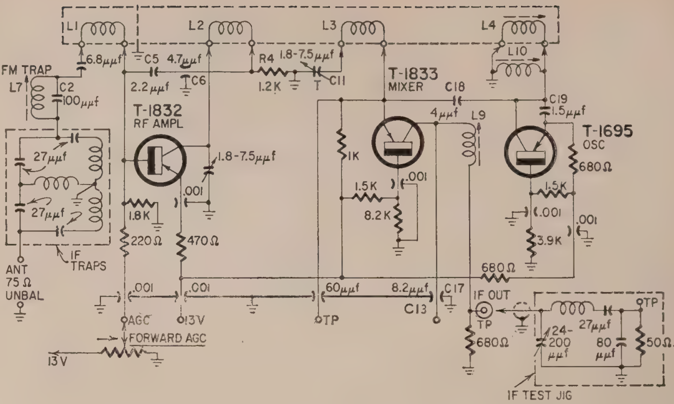
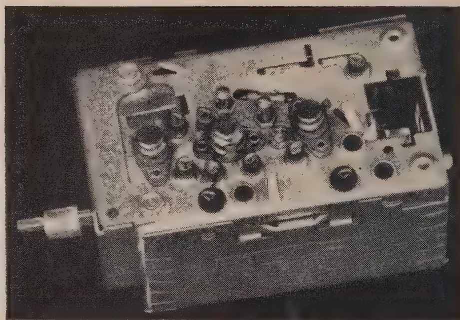
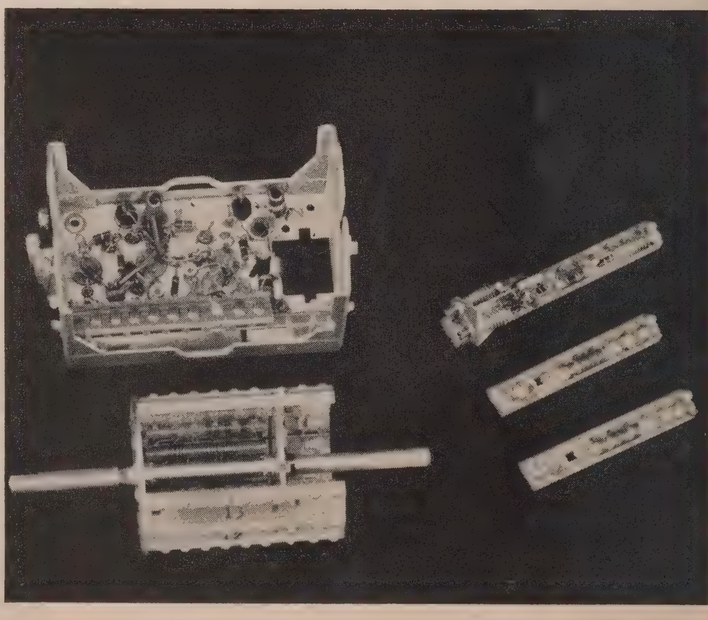


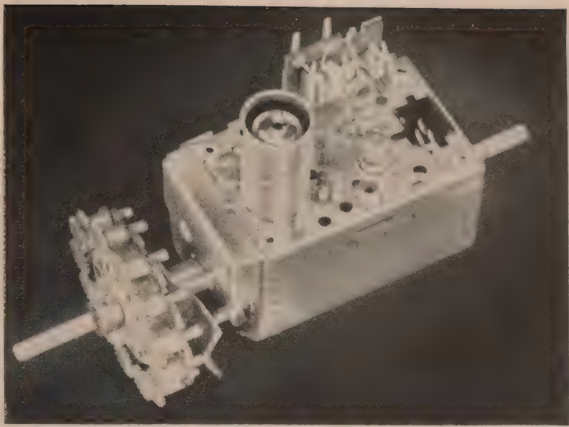
Fig. 1—Circuit of the Standard transistor tuner used by Motorola.

The Standard Coil transistor tuner.



Standard tuner with insides exposed.





Nuvistor tuner uses one nuvistor and one standard vacuum tube.

uhf reception as well as vhf by adding typical uhf strips similar to those used with Standard's familiar cascode and neutrode tube type tuners. Noise figures with the transistor tuner approach those obtainable with vacuum tubes—for example, 14 db measured with a channel 29 uhf strip inserted. Bias voltage for the mixer diode in the uhf strip is supplied by the vhf tuner, and the uhf mixer is forward-biased to assure a respectable noise figure. In uhf operation, the conversion to 45-mc if occurs in the uhf strip, as is the usual practice with tube type tuners. The rf amplifier and mixer are both used as if amplifiers.

Physical dimensions of this new Standard transistor tuner are almost identical with those of the present miniature Guided-Grid tuner and the new miniature nuvistor tube type tuner developed for RCA by Standard-Kollsman, except that there is a saving in height in the transistor unit since tubes and tube shields are eliminated.

Nuvistor tuner

This new vacuum-tube tuner using nuvistors is now in production by Standard. Essential features of this kind of tuner were described (RADIO-ELECTRONICS, page 48, January, 1961). A neutralized triode or neutrode rf amplifier is used. Gain figures for the tuner range from 42 db at channel 2, to 40 db at channel 13. Noise figures are 3.5 db and 5.0 db, respectively, for the same channels. Performance with the nuvistor tubes is considered excellent by Standard engineers. END

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Karl Wittig, "Transistorized TV and FM Tuners." Standard-Kollsman, Inc., Los Angeles: *Semiconductor Products*, July 1960.

E. D. Lucas, Jr., "TV Tuner with a Guided Grid." *Radio-Electronics*, January, 1960.

Fig. 2—Specifications for the Standard tuner.

CHAN	POWER GAIN (DB)	NOISE FACTOR (DB)	IF REJ. BALANCED (DB)	VSWR (WORST)	BAL. TO UNBAL. (DB)	MAXIMUM GAIN REDUCTION (DB)	IMAGE REJ. (DB)	FINE TUNING RANGE (MC)
2	41	6	>60	<2/1	35	52	>70	6.0
3	40	6		↑				
4	39	6						
5	37	6						
6	36	6	>60		31	45	>70	5.4
7	27	8	>70		30	36	>60	5.0
8	27	8						
9	26	8						
10	25	8	>60		25	35	>60	5.0
11	25	8.5						
12	24	8.5		↓				
13	23	8.5	>60	<2/1	23	35	52	5.0

a loud picture

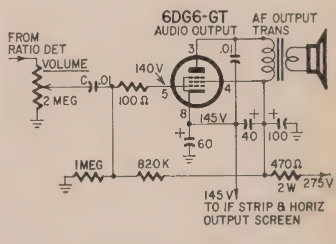
By H. R. HOLTZ

IT was strictly a routine call. No picture, sound bad. The first complaint was caused by a complete lack of high voltage. The second was justified by a definite hoarseness or muffled quality. Since I was going to pull the set anyway, to have an underchassis look at the horizontal circuits, I didn't bother much with the audio trouble, leaving it for the final stages of the bench work.

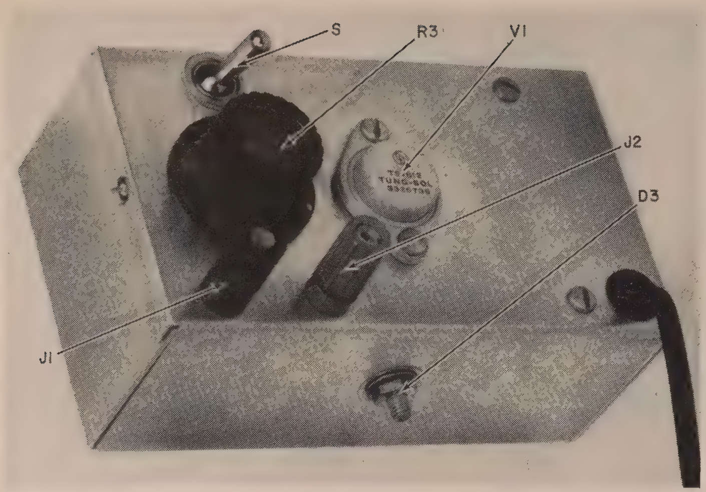
On the bench, I turned the set on and dawdled a moment before digging in (since it was a vertical-chassis Admiral of about 1957 vintage and I am just as lazy as the next guy about pulling the picture tube to get at the tube-socket wiring).

Quite inadvertently, I kicked the volume up to maximum. Lo and behold, a picture! I backed the volume off. No picture.

The partial schematic shows a typical arrangement of such a circuit. The cathode and grid of the audio output tube are at about 145 volts dc (the grid is actually a few volts lower to provide suitable bias). The cathode supplies the if plates and screens and the screen grid of the horizontal output tube.



Note capacitor C. At the low end of the volume control, the control grid is at ac ground through this capacitor. Now suppose this capacitor is shorted (as it was in this set). Now the grid is grounded, and 145 volts negative to the cathode. The tube cuts off, cathode voltage drops and the if strip and horizontal output stages are out. Only at high volume settings, with the volume control between it and ground, is the grid, and therefore the cathode, at high enough potential to supply the horizontal output screen. END



Simple supply makes a neat - looking package.

ELECTRONIC DRY CELL

Constant-impedance variable-output power supply for semiconductor projects

By
DONALD L. STONER

ANYONE who experiments with semiconductor devices soon learns that an adjustable power supply is necessary. He also discovers that the supply should be *well regulated* and have an *extremely low output impedance.*

This is particularly true of tunnel diodes. These devices operate on the negative-resistance slope of their characteristic curve (Fig. 1). As the supply voltage increases, the diode reaches a peak current. This point is called E_p and the current flow is, of course, I_p. From this point on, as the voltage across the diode terminals increases, current drops until it reaches a low or valley. From the curve you can see that the junction current drops even though the supply voltage increases. This indicates that the diode has *negative-resistance* characteristics.

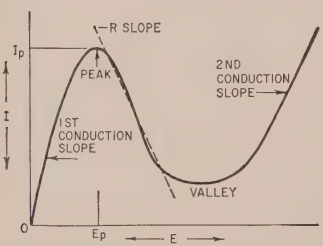


Fig. 1—Typical Zener-diode characteristic curve.

Negative resistance, whether in a diode or any other device, makes special demands of the power supply. In the Esaki diode, for instance, when the current drops, supply voltage will increase slightly if power supply regulation is poor. The increase in voltage is enough to carry the current down the negative-resistance slope, past the valley and up the second conduction slope. The same conditions exist when reducing the voltage. Thus, the diode will switch rapidly from peak to valley or the other way around. It will never rest between these two points as this can happen only if the impedance of the power supply is less than the negative resistance of the diode. This effect is used in computers for millimicrosecond switching of information bits.

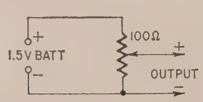


Fig. 2—Battery with series voltage control does not have constant impedance.

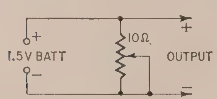


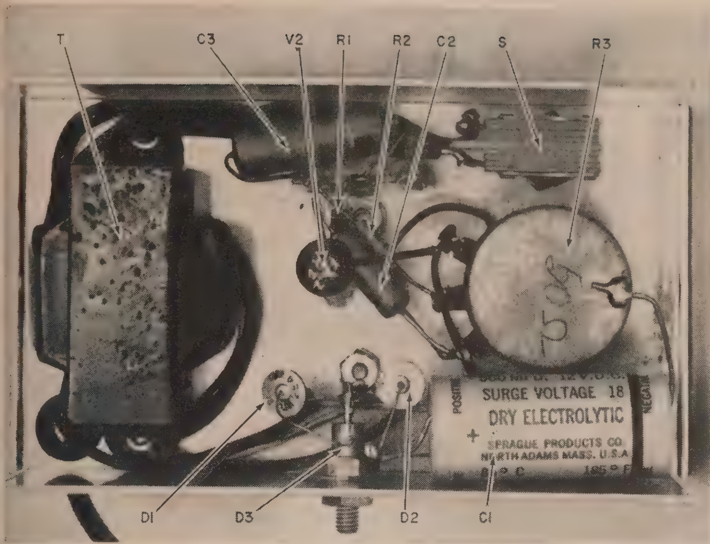
Fig. 3—Battery with parallel voltage control has short life.

Battery power

Batteries provide a simple, reliable method of supplying power to semiconductor devices. Although the fresh dry-cell battery has a relatively low internal impedance, it obviously is not adjustable. Many new semiconductor devices (tunnel diodes, controlled rectifiers, etc.) require voltages less than the 1.57 volts supplied by a fresh cell. Any attempt to reduce the voltage of a 1.5-volt cell will either raise the source impedance or cause excessive battery drain!

As an example, Fig. 2 shows a 100-ohm potentiometer connected as a voltage divider across a 1.5-volt battery. For an output of, say, 0.75 volt, the potentiometer would be set in the center of its resistance range. Thus the source impedance would be approximately 25 ohms since the two halves of the potentiometer are essentially in parallel. If we arbitrarily say that the battery has an internal resistance of 1 ohm, then you can see the potentiometer has destroyed the impedance and regulation by a factor of approximately 25.

Another method of lowering battery voltage is shown in Fig. 3. Here a potentiometer is connected in parallel with the battery to provide a variable load. As the resistance is decreased, the



With the back of case removed, parts layout is revealed.

battery voltage will naturally drop. It is likely that the combination of the potentiometer in parallel with the internal resistance of the battery would lower the source impedance to less than 1 ohm. Although this gives us a low source impedance, it obviously discharges the battery in a very short time.

Electronic supply

Although batteries might seem to be a convenient power source, an electronic power supply is more satisfactory. Fig. 4 shows a very simple device that has a very low output impedance.

Both line and load regulation is excellent. To duplicate a single dry cell, less than 2 volts is required. A center-tapped 6.3-volt filament transformer serves as the power transformer. Two replacement type silicon rectifiers are connected in a full-wave circuit. The voltage output from the rectifier is regulated by a 3.9-volt Zener diode.

Since the regulation point (out of the rectifier) is higher than needed for the intended application, series regulator transistor V1 is used to drop the output terminal voltage. The gain of this transistor (and therefore the output voltage) is varied by control transistor V2.

If load current decreases, and voltage across R3 increases, more negative bias is applied to V2. This, in turn, causes the junction resistance of V2 to *decrease*, thereby reducing the bias applied to V1. Transistor V1, then *increases* junction resistance, which returns the output voltage to near its original value.

Ripple can be a serious problem in power supplies for semiconductor circuits. Most semiconductor devices are voltage-sensitive and even a tiny periodic variation in supply voltage will affect their performance.

In addition to regulating changes in dc (just described), the response time of the regulator circuit is fast enough to cancel hum. Any ripple voltage which appears across the load is coupled to the base of V2 through capacitor C2. For example, let's say there is a negative-going alternation at the junction of V1 and C2. This signal, coupled to the base of V2, increases the current flow in V2 and reduces it in V1, as before. This increase tends to counteract the ripple. With the component values shown, the correction is almost complete, which brings about near-perfect hum cancellation. The output ripple and impedance are so low that a 500-μf capacitor connected across the terminals will not reduce the remaining ripple noticeably!

Let's build one

The layout of the adjustable power supply can be seen in the photos. The collector of the current-passing (series regulator) transistor is made common ground so V1 can be mounted directly to the chassis without insulating washers. A 3-lug terminal strip is mounted under each lug securing transistor V1. The terminal closest to the ac switch provides tie points for one side of the line cord, the ground end of C3 and R1, and V2's base. The other strip is used for the junction of the transformer and the rectifiers, the transformer center tap and the Zener diode ground. For convenience, C1 is grounded to the frame of R3.

The transformer loafs along since each half of the winding supplies power on alternate half-cycles. Any center-tapped unit supplying 600 ma or more is quite adequate.

The Zener diode is also much larger than required for the job since it can dissipate 3.5 watts. Almost any Zener diode which regulates between 3 and 4 volts will work in this supply.

The experimenter can also use any one of several transistors in this power supply. A few of the types I tried are given in the parts list. The current-passing transistor, V1, should have a low saturation resistance. The control transistor, V2, should have a beta of at least 30.

I used a General Electric 2N43-A controlling a Tung-Sol TS-612, as shown in the photograph. The transistors shown in the parts list were all tried and worked equally well.

Final setup and operation

The supply is almost foolproof, but there are several components you can adjust for maximum performance. The optimum capacitor values in the hum-cancelling feedback network (C2 and C3) appear to be different for some transistor types.

To obtain an absolute minimum of hum and ripple, connect the power supply terminals to the input of a high-gain audio amplifier. Set the VOLTAGE ADJ potentiometer for 0.6-volt output and try substituting various capacitor values for C2 and C3. You will find definite values which give minimum ripple as heard in the amplifier.

The supply is used just as if it were a variable battery. With the knob fully counterclockwise, the output voltage is approximately 0.1 volt. As the knob is rotated clockwise, voltage increases to a maximum of 2.5, somewhat higher than the average dry cell. END

R1, R2—1,000 ohms, ½ watt
R3—pot, 50 ohms, wirewound
C1—500 μf, 12 volts, electrolytic
C2—4 μf, 6 volts, electrolytic
C3—.033 μf, 600 volts, paper
D1, D2—silicon rectifiers, 400 volts, 200 ma (International Rectifier 2E4 or equivalent)
D3—Zener diode, 3.9 volts (International Rectifier 1N1589 or equivalent)
J1, J2—3-way binding posts
S—spst toggle
T—filament transformer: primary, 117 volts; secondary, 6.3 volts ct, 1.2 amps (Triad F-14X or equivalent)
V1—2N307, 2N301, 2N256, 2N243-A, TS-612
V2—2N43-A, 2N217, 2N407, 2N408, 2N1380
Chassis, to suit
Miscellaneous hardware

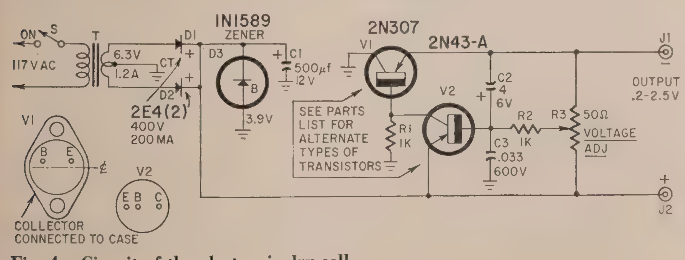


Fig. 4—Circuit of the electronic dry cell.

ELECTRONIC WATCH REPAIR

New field for the technician —keep the watchmaker's electronic equipment up to par

AS first electrical and now electronic wristwatches appear on the market, the fields of the watch repairman and the electronic technician come closer together, indeed overlap. We have had electronic watch timers for some time[1] as well as ultrasonic watch cleaners.[2] Now an electronic test instrument designed for testing and adjusting a watch has appeared. Manufactured by American Time Products, it is intended to check the new Bulova Accutron electronic watch.

Earlier watches simply replaced the old mainspring with a power cell. They retained the hairspring, balance wheel and escapement of the spring-wound watches. The Accutron abandons the traditional balance wheel, using that acknowledged standard of frequency, the tuning fork, both as regulator and driver. Since the fork is driven by a transistor switch, Accutron repair is a job that requires the knowledge and skill of the electronic technician rather than that of the old-time watchmaker.

The tuning fork is the heart of the design of the Accutron, as the new device is called. Electrical energy delivered and controlled by the circuit causes the fork to vibrate. These vibrations are converted mechanically to rotary motions and, in turn, transmitted through a gear train to the hands. (See Fig. 1.)

The tuning fork is about 1 inch in length. On the tip of each tine is a magnet assembly which consists of a cuplike piece of magnetic material and a conical-shaped magnet mounted within the cup—actually a small pot magnet, similar to those on loudspeakers.

A strong magnetic field lies between the magnetic cone and cups. Coils of wire shaped to match the conical magnet are interposed in these magnetic fields. An alternating voltage is induced in the coils as the magnets vibrate.

As the tuning fork vibrates at 360 cycles per second, a voltage is induced in the coil in the transistor's base circuit. This voltage, interacting with a capacitor and resistor, together with the power-cell voltage, causes the transistor to become conductive for a split second during each vibration of the fork. Whenever the transistor, acting as an electronic switch, is switched on, it allows a surge of current to reach the driving coils. These pulses of current maintain the vibration of the fork at 360 cycles.

On one tine of the fork is a tiny fingerlike spring tipped by a tiny jewel. This is termed the index finger. Its job is to push on the ratchet teeth of an index wheel 360 times per second—once for each vibration of the fork. The pushing force rotates the index wheel. The wheel, which is smaller than a pinhead and about half a hair in thickness, drives the wheel train that moves the hands of Accutron. A similar jewel-tipped spring finger serves as a pawl to hold the wheel ready for the next push.

The design of the indexing mechanism permits a wide range in the extent of tuning-fork vibratory motion (which results in a wide range of travel of the index finger) before it would tend either to advance the wheel more than one tooth or not advance it at all. Any advance other than one tooth for each tuning fork vibration, of course, would make the hands run too fast or too slow. If amplitude tends to deviate from a specific designed-in value, the electronic circuit senses this and instantly returns the fork to its proper range of amplitude.

[1]"Modern Watch-Rate Recorders," RADIO-ELECTRONICS, August 1953, page 26
[2]"Sound Does the Cleaning," RADIO-ELECTRONICS, July 1959, page 30.

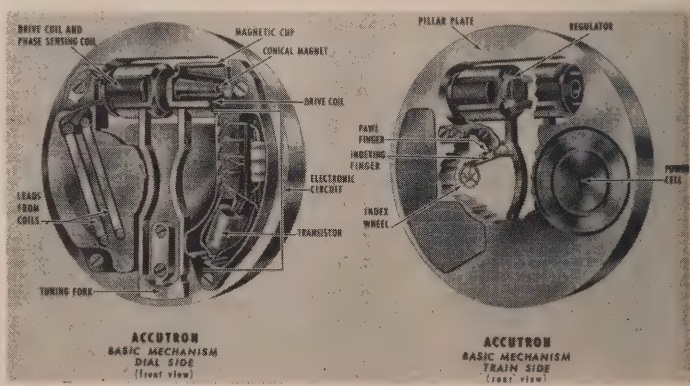


Fig. 1—Highly simplified drawing shows internal arrangement of the Accutron. Essential mechanism is clearly illustrated. When testing an Accutron, the power cell is removed and a power adapter from the test unit is connected in its place.

The tuning-fork assembly and the electronic circuit are modules which can be removed and replaced by a jeweler if they are damaged.

Accutron is powered by a tiny 1.3-volt mercury cell guaranteed to last at least 1 year.

The watch checker

The meter used for checking the watch has three functions:

▸ To check the voltage of the Accutron power cell.

▸ To check the current drawn by the electronic circuit of the watch.

▸ To supply voltage, both at normal and at reduced levels, for checking and adjusting the indexing mechanism.

One important requirement was so to design the meter as to have protection against damage to the meter movement, and further to safeguard against the needle slamming violently against its stop, even though that might not produce damage. (The thinking here is that, if a watchmaker accidentally shorted his test leads and saw the needle slam, he would be inclined to believe his instrument's accuracy had been impaired. Consequently a circuit was evolved which provides such safeguards.)

The safety is provided by purposely having a high-resistance dc supply. Even when shorted, current through the meter is limited to only slightly over full-scale current.

In checking a movement, the first operation is to insert the power cell taken from the watch into the meter to check its voltage. If the voltage is outside the OK limit on the scale, the cell is replaced.

The next step is to check the Accutron operation. With the checked power cell in the test set, and the test-set connector replacing the power cell in the Accutron, switch S1 is moved to position 2 MICROAMPERES.

Transistor V and coil L with its interwinding capacitance make up a Hartley type oscillator. Frequency of oscillation is approximately 100 kc; the amplitude between collector and ground is twice the supply voltage or 2.6 volts peak to peak. D1 rectifies this voltage, charging capacitor C2 to the peak-to-peak voltage of −2.6.

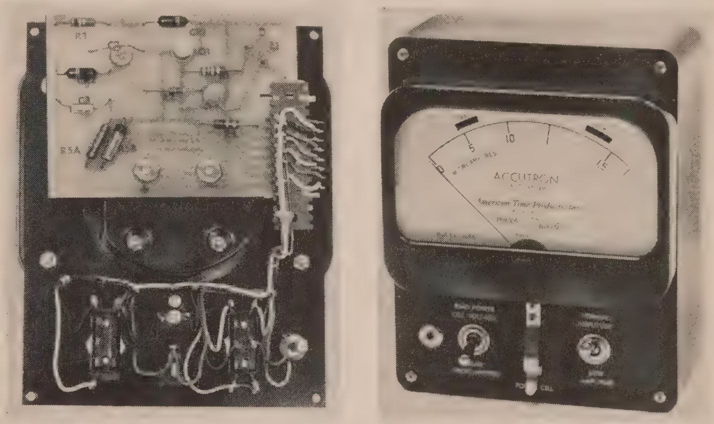
With switch S2 in NORMAL AMPLITUDE position, 2; switch S1 in MICROAMPERES position, 2, and no plug in jack J1, the bleeder across charged capacitor C2 consists of R3, D2 and the power cell in series. Diode D2 is forward-biased, thus the drop across it is close to 0.1 volt. The bleeder current is approximately 12 μa, and the voltage at the junction of R3 and D2 is −1.4 with respect to ground, charging capacitor C3 to that voltage.

When an Accutron is inserted in the Accutron connector and the plug is inserted in jack J1, the bleeder across C3 consists of the meter and the Accutron in series. The meter reads approximately 6.2 μa. The current through R3 divides so that 6.2 μa goes through the meter branch and approximately 6 μa goes through diode D2. The balance is arrived at by the condition required to keep D2 biased in the forward direction. If more than 12 μa were to flow in R3, the voltage at the junction of R3 and D2 would become more positive than the negative end of the power cell and diode D2 would become reverse-biased, cutting off the branch through D2. This, therefore, establishes the maximum current through R3 for keeping the power-cell in the Accutron circuit. The Accutron sees a low-impedance source consisting of the series string of the meter movement, forward-biased diode D2 and the power cell.

If for some reason the Accutron circuit draws more than the 12-μa total current, the voltage at the junction point of D2 and R3 becomes less negative than −1.3 volts, cutting off D2. Under this condition, the source impedance for the Accutron is high, limiting the maximum current through the meter, which cannot exceed 26 μa when completely shorted. For normal operation, the needle indicates in the safe region, 5.8 to 6.5 μa.

For low-amplitude operation, switch S2 is moved to position 1, introducing voltage divider R2 and R4 across the power cell. Thus the divided voltage is used to actuate the Accutron. For this condition, the current is reduced but should not fall below 4.5 μa. This simulates the condition of a power cell which is close to the end of its life but is still usable. The Accutron must operate satisfactorily under this condition.

The circuit was developed by the Bulova Watch Co., Jackson Heights, N. Y., and as stated above, the meters are made by American Time Products Inc., a Bulova subsidiary. END



Front and rear views of Accutron tester.

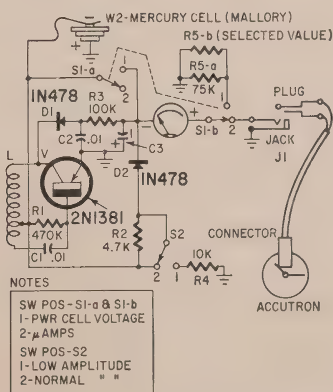
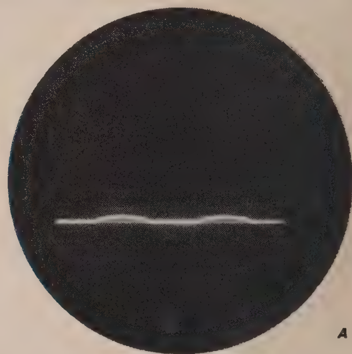


Fig. 2—Schematic of Accutron test set.

Four-layer diodes & controlled rectifiers What are they?

Two of the more recent semiconductors open a whole new field in switching and thyratron applications

By GENE JACKSON



DURING the last decade, transistor development has progressed rapidly and received world-wide publicity. This is as it should be, but other developments in the semiconductor field should not be neglected. Some of these devices promise to play a very important part in the electronics of the future. Two examples are the four-layer diode and a modification of this basic device—the controlled rectifier.

The ordinary junction diode consists of a layer of P-type crystal joined to a layer of N-type crystal. It can be forward- or reverse-biased. With forward bias, the P-type material is made positive with respect to the N-type and the diode conducts. When the diode polarities are reversed, reverse bias results and very little current flows.

The four-layer diode has two N-regions or layers and two P-regions as shown in Fig. 1. Under normal operating conditions, the center p-n junction is reverse-biased and the outer p-n junctions are forward-biased. To illustrate the effects of this arrangement, an equivalent structure is shown in Fig. 2.

Here, a four-layer diode is represented by two transistors connected as shown. Notice, too, that the p-n-p transistor is correctly biased. The emitter-to-base junction (J1) is forward-biased and the collector-to-base junction (J2) is reverse-biased. Bias conditions occur in the n-p-n section are also correct. It is shown that I_{B1} equals I_{C2}, and I_{C1} equals I_{B2}. If this unit can be caused to begin conduction and increase the current through it to a certain critical point, this internal feedback mechanism sustains conduction.

To explain this, we can further state that any transistor has a value of alpha (α). This is indicated by:

$$\alpha = \frac{I_C}{I_E} \text{(disregarding minority carriers)}$$

Or: $$I_C = \alpha I_E$$

Alpha is the portion of the majority carriers leaving the emitter and reaching the collector. In an ordinary transistor, alpha is made as large as possible to get the highest forward-current transfer ratio or current gain.

Referring again to Fig. 2, the majority carriers in an n-p-n transistor are electrons. This is shown by the solid arrow. Because the majority carriers in the p-n-p section are holes and they move from positive to negative polarities, this current flow is shown by a dashed arrow. The current crossing J2 is $\alpha_1 I_T + \alpha_2 I_T$. Because of minority carriers, we cannot ignore the value of I_{CBO} or reverse current present to some extent in all semiconductor devices.

Therefore the total current across J2, which is actually the current through the entire device, can be shown as:

$$I_{J2} = I_T = \alpha_1 I_T + \alpha_2 I_T + I_{CBO}$$

And: $$I_T(1 - \alpha_1 - \alpha_2) = I_{CBO}$$

$$I_T = \frac{I_{CBO}}{1 - (\alpha_1 + \alpha_2)}$$

This indicates that if $\alpha_1 + \alpha_2$ equals unity, the current in the diode is limited only by the external circuit.

If α_1 and α_2 are close to zero, the current through the diode is approximately equal to I_{CBO}. Because J2 is reverse-biased and base current from both equivalent transistors must in some way cross this junction, there is only this leakage current available unless some method is found for "triggering" the unit. This nonconducting condition of the four-layer diode is the "blocked" state.

Some method must be found to increase alpha if this device is to be useful. Two methods are generally used. One is to increase emitter current directly; the other is to increase the collector voltage and thus indirectly the emitter current. As in ordinary transistors, alpha or current gain increases with emitter current. Fig. 3 is a curve of alpha vs emitter current.

The author wishes to thank the Public Relations Div. of Texas Instruments Inc. for its permission to use data from the May 1960 issue of Application Notes *as a source of information for material in this article. Many of the circuits discussed were constructed and results verified in the Training Aids Laboratory of the Educational Services Section of Convair, a Division of General Dynamics Corp., Fort Worth, Tex.*

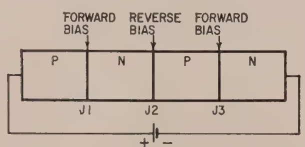


Fig. 1—Structure of a 4-layer diode.

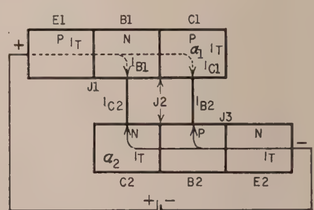


Fig. 2—Equivalent diagram shows two transistors connected to form a 4-layer diode.

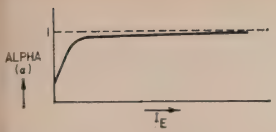


Fig. 3—Alpha vs emitter current for a 4-layer diode.

If the voltage across the entire unit is increased to a certain critical point, the center junction, J2, breaks down (triggers) and allows reverse current to flow through it, and thus emitter current and alpha increase.

The effect of this phenomenon is that the diode continues to conduct even if the high breakdown voltage is decreased. The device has switched from its "blocked" condition to its "on" condition. It will remain in this state as long as the current through J2 is great enough to cause $\alpha_1 + \alpha_2$ to be equal to

Fig. 4, the unit then acts like any reverse-biased diode. If the voltage reaches the breakdown point or Zener voltage, current through the device increases. However, the voltage across the diode does not decrease, and it could be used for voltage regulation. This is not, however, its most useful application.

Typical application

Perhaps a discussion of a typical application of this diode would be useful in pointing up its possibilities. Fig. 5 is a partial schematic of a circuit using such a diode.

In Fig. 5, R1 and R2 act as a voltage divider across the negative 100-volt supply so that approximately −60 volts appears at point A. As the breakdown voltage of the four-layer diode is 80 volts, it does not conduct until additional voltage is applied across it.

When a negative-going signal is applied to V1's control grid, a positive pulse of over 20 volts amplitude ap-

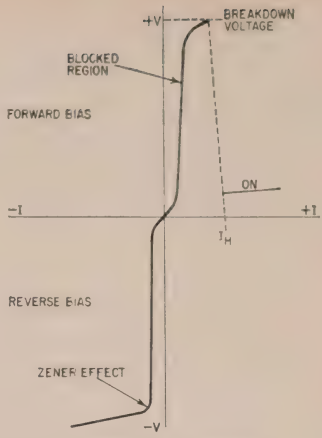
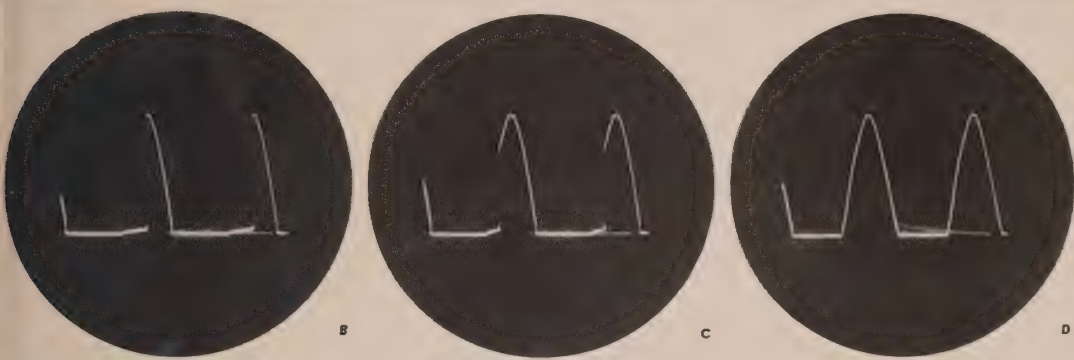


Fig. 4—Forward-bias voltage vs current for a 4-layer diode.



Controlled rectifier in circuit of Fig. 8 produces these scope patterns: a—R1 set for zero gate current. There is no anode current. Low-amplitude waveform is result of minority carriers only. b—I_G is large enough to cause some conduction, but not during the entire positive alternation. c—A still higher value of I_G causes this waveform. d—V_G has been advanced until the firing point occurs very early in the half-cycle.

unity. The current at this time is limited almost totally by the voltage applied and the resistance in the external circuit, as the resistance of the diode is now extremely low. The minimum current that must flow through J2 and also in the external circuit to maintain this "on" condition is called the holding current, I_H.

This plot of forward-bias voltage current is in Fig. 4.

If the polarity of the voltage across the diode is reversed, J1 and J3 are reverse-biased and J2 is forward-biased. The effect then is similar to two reverse-biased diodes in series. As shown in

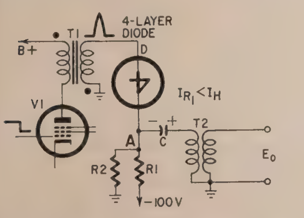


Fig. 5—Possible circuit uses 4-layer diode switch.

pears at V1's plate and across T1's secondary. This increases the potential difference across the diode past 80 volts and it conducts. At this time the resistance and the voltage drop across the diode become very low. Effectively, the secondary of T1 and C, which is charged to the polarity shown, is applied directly across T2's primary. Thus, a pulse of slightly more than 20 volts results in a signal of more than 80 volts across T2's primary. Although the four-layer diode cannot be called an amplifier in a true sense, it actually amplifies the input signal.

The diode will very shortly block or go to a nonconduction state because, when C has discharged and the trigger input at T1 has elapsed, there is not enough current (I_H) to hold D in a conducting state. R1 is chosen so that D's I_H is greater than the current through R1 with a 100-volt drop across it. The circuit then recovers, C again charges to the polarity indicated and another input pulse may be applied.

The controlled rectifier

Another method of turning this type of device "on" without reaching the breakdown voltage across the diode is used in the controlled rectifier. A structure diagram of this unit is in Fig. 6. Fig. 6-a shows the necessary electrical connections and polarities. Fig. 6-b is the equivalent structure diagram.

When operating below the breakdown voltage, the device is in its blocked state and only I_{CBO} flows in the circuit. However, we have now added another connection to this modified four-layer diode or controlled rectifier—the gate lead connected to the center P-region.

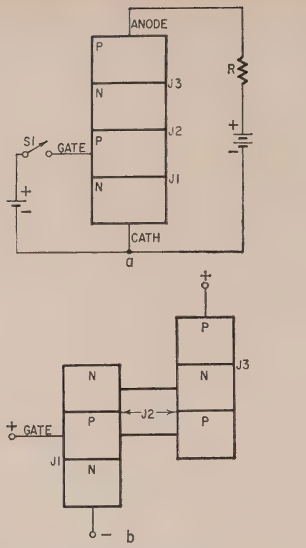


Fig. 6—Controlled-rectifier construction and 2-transistor equivalent arrangement.

If a positive voltage is applied to the gate lead, current flows in this part of the circuit as this represents forward bias for J1. Because of transistor action, some of the electrons from the cathode drift across the first P-region (actually the base region for the equivalent n-p-n transistor) and enter the second N-region by diffusing across J2. Because J3 is forward-biased, electrons and holes combine in the area of J3. This results in electrons leaving the anode circuit from the top P-region and causing holes to form here. Thus, current has been increased through the device.

Furthermore, as the holes formed near the anode lead drift across the P-region and cross J3, some combine with electrons from J2 and some diffuse across J2 and enter the next P-region. Transistor action has now been accomplished in both equivalent transistor sections. As the current through the device is thereby increased, alpha or current gain of both sections increases. This results in further increase in current and alpha until the unit saturates.

We have seen that, once the gate current reaches a certain point, the device turns "on" and the current through the controlled rectifier is limited only by the voltage and resistance in the external circuit. This is similar to the action of a thyratron where the grid voltage controls the firing point. The controlled rectifier has the advantage of a very small voltage drop across it when conducting. This means that a controlled rectifier can be used where a thyratron might be impractical.

Another advantage of this arrangement is that a small gate current, I_G, can cause a large change in anode current. This action is shown graphically in Fig. 7.

If there is no gate current, the voltage across the device must be increased until the breakdown voltage is reached to cause the device to turn "on". The current then increases and the voltage across the unit is small. As the gate current is increased, the controlled rectifier will fire with less voltage across it. This is indicated in Fig. 7 where $I_{G0} < I_{G1} < I_{G2} < I_{G3} < I_{G4}$.

Demonstration circuit

A simple circuit that can be used to demonstrate the characteristics of the controlled rectifier is shown in Fig. 8. A Texas Instruments 2N1595 controlled rectifier diode is used.

If a rectifier with high enough breakdown voltage (B_V) and power dissipation ratings is used, the transformer may be eliminated and the line voltage connected directly across D. Be sure that the maximum permissible gate current is not exceeded at any time.

With R1 set for zero gate voltage, there is no anode current. This is shown in Fig. 9-a. The low-amplitude waveform is the result of minority carriers only (I_{CBO}). The scope's vertical gain had to be increased for this photograph so this conduction would show up.

As potentiometer R1 is adjusted so that gate current flows, a point is reached where the diode begins to conduct on part of the forward voltage alternation. This is because, with a higher gate current, the rectifier turns "on" with a smaller forward voltage. Fig. 9-b shows a condition where I_G is large enough to cause some conduction, but not during the entire positive alternation. Fig. 9-c illustrates a still higher value of I_G.

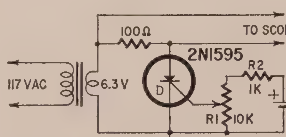


Fig. 8—Demonstration circuit using a controlled rectifier.

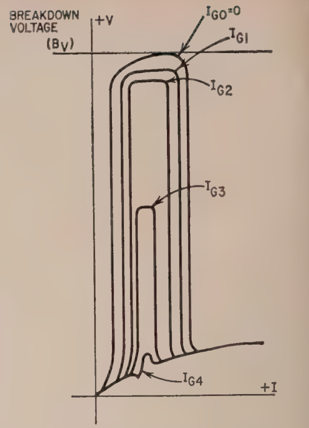


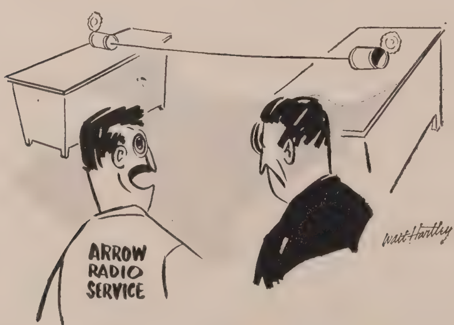
Fig. 7—Effect of I_G on anode current for a controlled rectifier.

R1 can be adjusted to change the firing point while observing the result on the oscilloscope. As V_G is increased, the firing point occurs earlier in the half-cycle until the waveform of Fig. 9-d results. This is a typical half-wave rectifier output. Notice that, if the firing does not occur on the positive-going portion of the positive alternation, it does not occur during the negative portion as the voltage across the rectifier is now decreasing. There is a small irregularity in the extreme lower trailing edge of the rectifier output. This is caused by the current through the rectifier dropping below the holding current of the device.

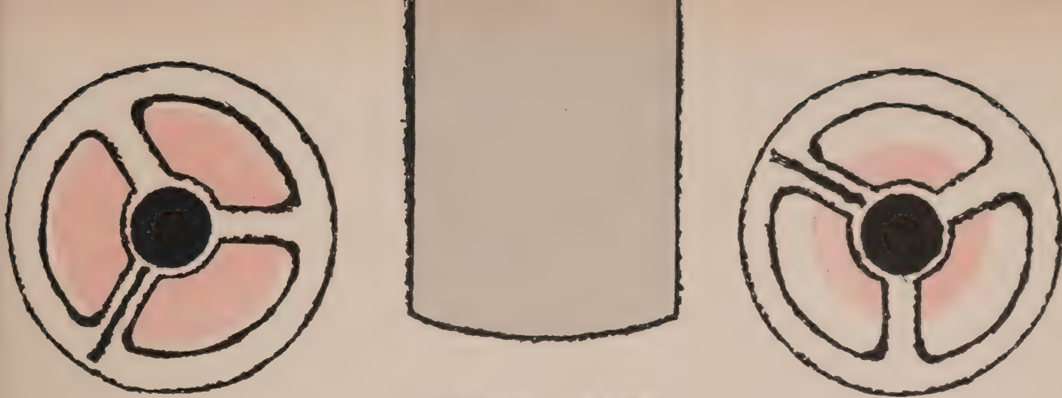
The controlled rectifier must be turned "on" again during each positive alternation as it will "block" during each negative alternation and the entire process is thereby repeated.

An interesting variation of this circuit is to substitute an alternating-current source for the battery. If the gate goes positive at the same time as the anode, the unit conducts. If not, the device remains cut off. This suggests many possibilities of using the p-n-p-n controlled rectifier as a phase detector or servo system control device, etc.

As the electronics industry becomes more aware and informed of p-n-p-n rectifiers, many additional applications will be uncovered. The uses of controlled rectifiers in the future are limited mainly by the imagination and ingenuity of designers. Controlled rectifiers are already being used in control circuits, pulse-generating systems, switching circuits and other such applications. As the state of the art is extended, more and varied circuit functions using these devices will be coming into general use. END



"You said you wanted a cheap intercom!"



SERVICING TAPE RECORDERS

The electronic portion of the tape machine is the service problem this month

By JACK DARR
RADIO-ELECTRONICS SERVICE EDITOR

TAPE recording has become a big business. Seventy-six manufacturers are listed in my latest service-data index, and this includes only home type recorders. Others make professional recorders for broadcast radio, TV and telemetry work. However, this article will deal only with home tape recorders, since they are what the average technician sees most.

In the course of our daily work, we made a most disquieting discovery. In service data on these machines, some very useful information has been either omitted or given in such a way that it is unusable by the service technician with standard shop equipment!

Magnetic recording

Let's run briefly over some of the basic theory first.

The whole thing started back before 1900, when a happy Dane named Valdemar Poulsen discovered that sound signals could be recorded on a piece of iron wire.

Today magnetic tape has replaced the wire. It is usually an acetate or Mylar plastic, ¼ inch wide and about .0015 inch thick. It is coated with a red ferrous oxide to a thickness of .0006 inch. Mylar bases can be thinner, allowing more tape to be wound on the same size reels.

How can we get a magnetic field varying with the audio signals? We feed the signal through an amplifier to raise it to the level needed and then through a coil of wire, past which the tape is being pulled (Fig. 1-a). The coil has an iron core with a gap in it to concentrate the magnetic field where we want it. This is the recording head. The narrower the gap (Fig. 1-b), the higher the efficiency of the head, especially at high frequencies. Early heads used wide gaps as compared to later types. In modern heads, the gap is as narrow as .001 inch, and some high-fidelity playback machines have gaps of only .00025 inch!

How do we get the signals back off the tape and convert them to sound? Well, if we pass a conductor through a magnetic field, a current is generated in it. So, if we move a magnetic field (on the tape) past a stationary coil, we'll generate currents in the coil. Put these through an amplifier and speaker, and the sound is heard again.

Now, with this too-brief discussion of fundamentals out of the way, we can get down to more practical work. This month, we will discuss the electronic section, or as much of it as we can get in. Next time we'll hit the mechanical section, and, then, special tests, service techniques and peculiarities found in commercial tape recorders.

The amplifier

As we said, the major part of the electronic section of the tape recorder is the audio amplifier. Up to a certain point, it is a conventional voltage amplifier, operating in class A (Fig. 2).

The tubes used are specifically designed for low noise and hum. Their internal structures are heavily braced to avoid any tendency to microphonics. This is essential in this application. Tape recorder amplifiers must operate on the same chassis with one, two or three electric motors, belts and assorted moving hardware, which gives the amplifier a lot of unavoidable vibration. Therefore, the input tube (the most sensitive) must be completely free of any microphonism for a clean recording. Shock-mounted sockets are used on this tube in some models.

Amplifier testing

Now, let's check a recorder. I'm not

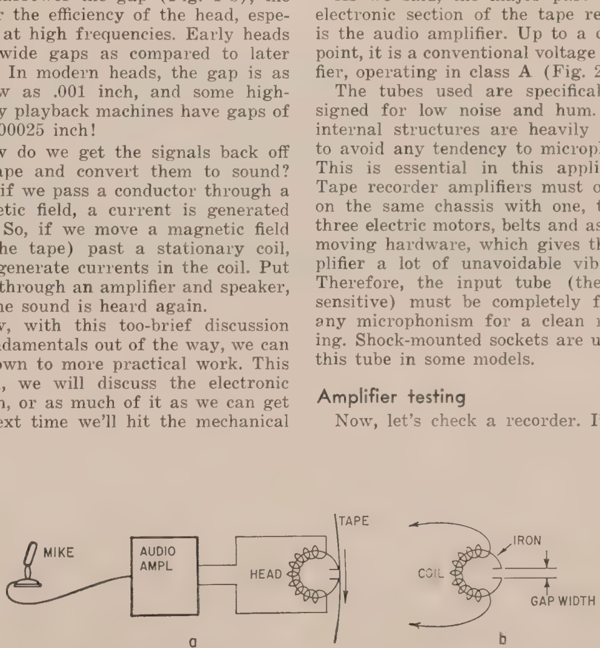


Fig. 1-a—How we put a magnetic field on the tape. b—Width of gap in iron core determines efficiency of recording head.

going to tell you to test the tubes and measure the dc operating voltages on each stage. You're supposed to have that already done! Let's assume that we have a tape recorder that isn't working right electronically. (Tape transport OK, just won't record.) So, we begin with the microphone.

Mikes used with these instruments are usually small crystal types, with an output of about −55 db. This is a bit higher than the output of broadcast and high-grade PA mikes, which run about −70 db.

There are several quick-checks for a mike. About the simplest is holding the mike to your ear and applying an ac signal through a blocking capacitor. You should hear the signal reproduced in the mike. Practically all mikes of this type will talk back—they will make sound as well as pick it up. Never connect dc directly to a microphone. Some types will be ruined by this procedure.

If the mike is dead, check the cable and connections.

Mike troubles are broken cables or loose connections. These usually turn up within 6 inches of the plug or mike, as these are the points of most flexing of the cable. If one end has been broken, it's a good idea to cut off about 6 inches of the other end and rework it too.

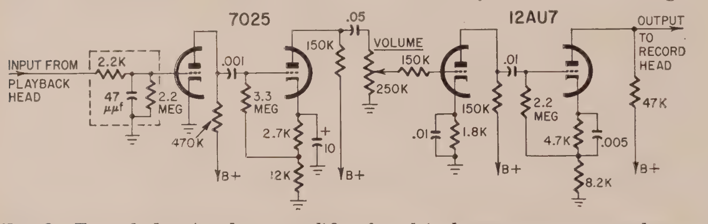


Fig. 2—Typical class-A voltage amplifier found in home-type tape recorders.

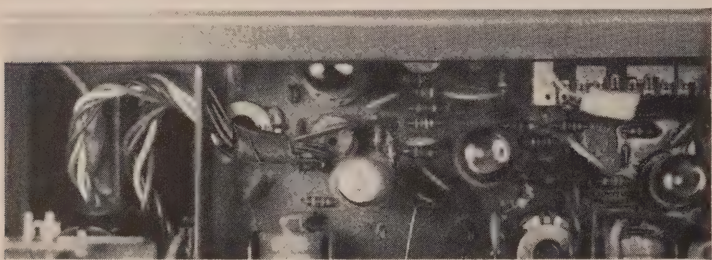


Fig. 3—Part of printed-circuit amplifier used in typical modern tape recorder. All parts are visible, and test points can be reached with long, thin test probe or extension.

There is a distinct possibility that several strands are broken at that end, and it may save you a callback!

With the mike checked out, let's go through the amplifier. After voltage readings have been checked, you can go through it with the low-capacitance probe. Most of the later-model amplifiers run pretty heavily toward printed circuitry, like the one in Fig. 3, so you'll probably have to use an extension on your probe tip. However, these amplifiers do have one advantage. All the test points you want are at least visible, if not too accessible, and you can run a full test on the amplifier without removing the recorder from the case. (Usually, that is!) Parts replacement follows standard printed-circuit practices.

Signal-tracing is still the quickest way to locate bugs in any piece of electronic equipment. The quickest way in a tape recorder is to set up the instrument, plug in the mike and set it to record. (Incidentally, if the motor annoys you, disconnect one of its leads to stop it!)

Connect the output of an audio signal generator to a single earphone or small PM speaker, set it about 400 cycles. (This frequency is picked as it is not affected by either low- or high-frequency compensation networks.) Place the mike close to the speaker to pick up the sound (Fig. 4). (If the mike is a small one, it can be laid face up on the bench, and the speaker placed cone down on top of it.) If the mike is defective or missing, you can apply the audio test signal directly to the input of the amplifier.

However, you'll have to be careful not to overload the input stage, which is always very high gain. This can cause very severe distortion and lead you to look for nonexisting troubles.

Set up a temporary voltage divider as shown in Fig. 5. Ordinary resistors of almost any size will do as long as their ratios are right. For example, the 100,000- and 1,000-ohm combination shown will apply about 10 mv to the input, if 1 volt is applied across the two from the generator. Other ratios can be used, as long as the total voltage applied to the input doesn't exceed about 10 mv, which is close to the output voltage you'll get from one of the small crystal mikes.

Now you're ready to go. Begin by locating and removing the bias oscillator tube to avoid interference in readings from bias leaking about the amplifier. Then check the waveform and value of the applied signal, just to be sure. Trace this through the amplifier. Sometimes a square-wave signal can be used to advantage but, for routine gain checking, a sine wave is fine. Notice the increase in pattern height as you go from grid to plate on each tube. This will tell you whether the stage has enough gain. This is also hot stuff for locating open coupling capacitors and bad switches!

In a conventional amplifier, you would expect the signal level to increase as you go from input to output. However, in a tape recorder amplifier, there are two special factors.

First, the recording amplifier uses equalizing networks to reduce the low-frequency and increase the high-frequency response to give a standard recording curve. The networks reduce signal level, and stage gain may seem to disappear. Because the networks are not always in the same places, before attempting to service a stage for "no gain," make sure that a compensation network is not causing the effect. Do not permanently disable or bypass these networks. They are necessary for the proper operation of the recorder.

Second, the output of the recording amplifier is used to drive the recording head, an inductive load. Connected directly to the tube plate through only a coupling capacitor, too much current would flow at low frequencies where the head has practically no impedance and almost shorts the output, and too little current would flow at high frequencies where the head impedance may rise to 50,000 ohms or more. The normal practice is, therefore, to add a series resistor as a constant-current device. Typical values are from 47,000 to 270,000 ohms. With the constant-current resistor, there is very little difference in current flow whether the head is shorted (low frequencies) or open (high frequencies).

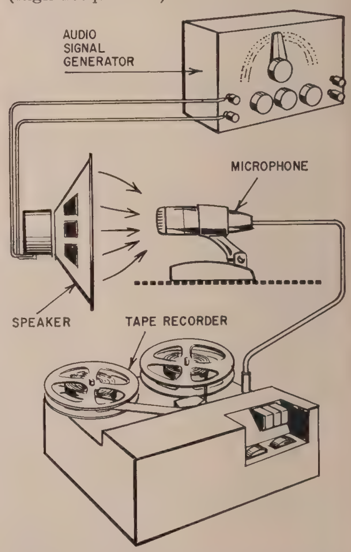


Fig. 4—Quick test setup for tape-recorder amplifiers. Speaker or earphone is connected to signal generator. Mike is placed close to pick up sound.

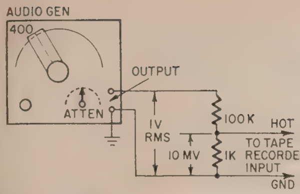


Fig 5—Voltage divider used to reduce input signal to prevent overloading.

After we get to the recording head, things begin to happen. What happens to our nice smooth sine-wave signal shouldn't happen to a dog! On the recording head, the same signal looks something like Fig. 6! This waveform was taken by connecting the probe directly across the recording head, after killing the bias by pulling the oscillator tube. The two waveforms of Fig. 6 are from different makes of well known recorders. All of those tested showed

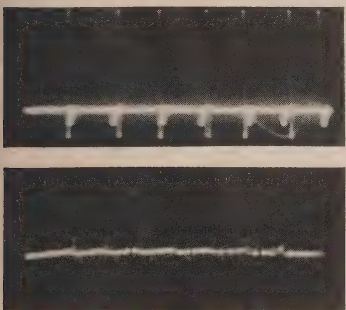


Fig. 6—Waveform of signal taken across recording head. Note heavy integration of signal. The two waveforms are of the same frequency signal, but were taken from different recorders.

basically the same waveshape, so we show only these two.

What's happened to our sine wave? Because of the nature of the *load* to which the signal is being fed, like the deflection yoke of a TV set, we must have a trapezoidal *voltage* waveform to produce a sawtooth *current* waveform. But we have, in the recording head, an almost pure *inductance*. So, to get a sine-wave current waveform in the head which will give us the best results in making the recording, we must feed it a "mess of spikes" instead of a nice pure sine wave.

The part values shown in Fig. 7 do not represent any particular amplifier. They're a sort of composite of several, to make up an output stage incorporating frequency compensation and bias coupling. Actually you'll have very little use for the waveform of Fig. 6; it was just thrown in to let you see what it actually looked like. Fig. 8 will be much more useful. This is a typical positive bias-signal waveform seen across the recording head with a low-capacitance probe. Signal frequency here is the same as that used before—400 cycles. Notice that the complete signal tends to show somewhat of a square-wave shape, with the bias included.

This is the actual signal that impresses the varying magnetic fields on the tape. The major part of this waveform is bias, at about 30 kc. The depth of modulation seen here is higher than what you should see in an actual test. We stepped the input signal up to a high level to show the "modulation" in the photograph. So, if your recorder doesn't show quite the depth of modulation, don't worry. Correct modulation should be just barely visible on the bias waveform.

Actual voltage readings in this important circuit depend on frequency of bias oscillator, type of recording head used, and the input impedance of the voltmeter, so are not usually a factor in servicing.

Actually, I feel that we can get all the information needed using a scope and the proper probe. They will quickly tell ús the three things we must know about the output of the amplifier and allied circuitry: 1—Is there bias present? 2—Is output signal reaching the recording head? 3—Does the amplifier have enough gain?

Actual bias and signal voltages on commercial recorders, as measured on several typical machines, run about like this: bias, 30–50 kc, about 130 to 150 volts peak to peak. Signal voltages, no bias present, from 5–50 volts peak to peak. Readings will vary quite a bit with head design, oscillator frequency and type of instrument used to measure. I'd suggest that you make your own set of voltage readings on every tape recorder you run into, and note them on the service data for future reference.

Bias-erase oscillators

We've been forced to refer to bias oscillators in some of the foregoing material before we had a chance to talk about them. Several oscillator circuits are in common use in tape recorders. They fall into two main classes: In some machines, the bias oscillator and output stage are combined in a single tube, usually a power pentode such as a 6AQ5. By switching, the tube operates both as an oscillator and audio amplifier. In some circuits it is used as output to the recording head and bias oscillator simultaneously! In fact, the circuit of Fig. 7 is one of these—the oscillator coil primary is in the cathode circuit! Feedback is through the two capacitors shown.

In other machines, a separate bias oscillator tube is used. It can be a simple tuned-plate oscillator as in Fig. 9-a or it may be a push-pull oscillator with transformer output, using twin-triodes such as the 6CG7 or 12AU7, as in Fig. 9-b. The operating frequency is determined by the circuit constants.

In any case, these simple circuits should offer no problems to technicians who service hundreds of these oscillator circuits in TV sets. If they work, fine. Do they have enough output? If not, find out why, just as if you were working with a weak horizontal oscillator in a TV circuit. Changes in operating frequency, unless very drastic, should have

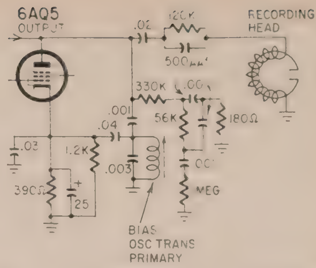


Fig. 7—Components in the 6AQ5 output circuit form an integrating network which changes the sine-wave signal into a series of pulses or spikes.

Fig. 8—Composite waveform, bias and signal, seen across recording head.

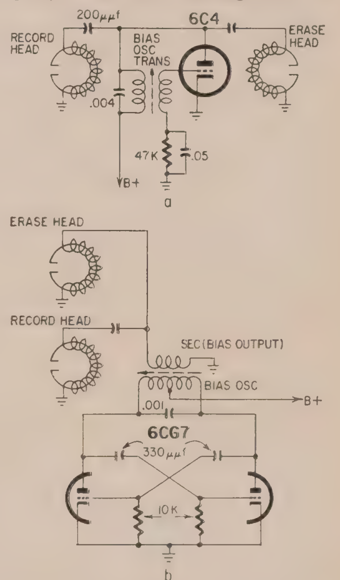


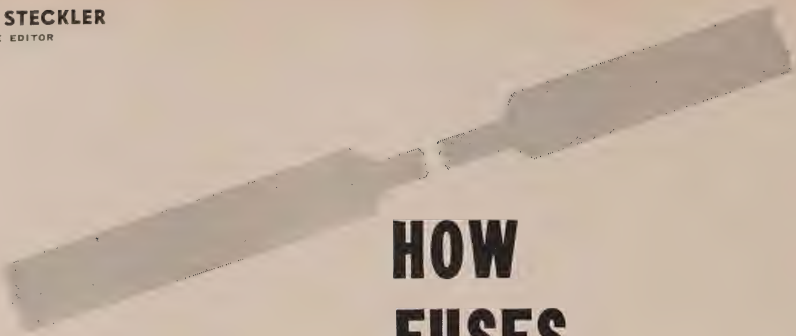
Fig. 9 — Two bias oscillator circuits, commonly found in tape recorders.

little effect upon recorder operation.

Well, it looks as if we've gone about as far as we can go this trip. Next time we'll take up such fascinating subjects as recording-level indicators, switching (which makes up a very large part of recorder servicing), the recording head, testing, aligning and demagnetizing heads, together with as many mechanical features as we can. See you next month.

TO BE CONTINUED

By **LARRY STECKLER**
ASSOCIATE EDITOR



HOW FUSES WORK

There's more to these tiny equipment savers than you realize

QUIETLY a screen capacitor shorts under continued stress. Current drain increases in the horizontal output tube. The flyback heats up. And a hair-thin filament inside a glass envelope melts away, restoring safety. This is what a fuse does!

Two leads in a line cord short. Sparks fly. Smoke starts to rise. And down in the basement a metal strip literally explodes. The current is cut off. That is what a fuse does!

The switch is thrown. Current is applied to a motor that doesn't start. The windings begin to heat up. Insulation starts to smoke. And a little pool of solder gets hot enough to melt, a spring lends its assistance. The circuit is opened and safe. That is what a fuse does!

A 10-volt meter is connected to a 300-volt source. The meter pointer heads for the pin at the top of its range. And a microscopic filament gives way. The meter pointer drops back to zero. That is what a fuse does!

These are examples of the important thing a fuse does—protects electrical circuits. But *how* does a fuse protect? What kinds of fuses are in common use? How do they differ? Where do you use them? These are the questions we will try to answer.

Pick up a fuse, any fuse. No matter what its shape or size, somewhere on its body are two important pieces of information—a voltage rating and a current rating. Let's see just what these ratings represent. We'll take the current rating first.

This is always in amperes or a fraction of an ampere and can range from 1/500 ampere up to any desired value. It simply represents the amount of current the fuse will handle without opening. Greater currents will make the fuse open.

The voltage rating isn't quite so simple. It represents the maximum voltage that can safely be applied to the fuse. A fuse rated at 250 volts can be used in any circuit as long as no more than 250 volts are applied. If more than 250 volts are applied to a 250-volt fuse, several things can happen:

▸ If the voltage is much higher than the fuse rating, it may arc across the fuse.

▸ When a fuse blows, a section of the fusible element literally explodes. But if too high a voltage is applied, this explosive force is greater as a larger section of the fuse link is vaporized. This can cause an under-voltage fuse to explode and send shattered case fragments into anything or anyone close by. The fuse is rated to withstand burnouts at its rated voltage, but will not stand up under excessive voltages.

▸ If a 250-volt 10-ampere fuse is used in a 250-volt circuit and the line shorts, the fuse blows. But no matter how much current goes through the fuse, it will not shatter when it blows.

Types of fuses

With some variations there are three basic types of fuses—fast-acting, standard and delay. The fast-acting fuse is

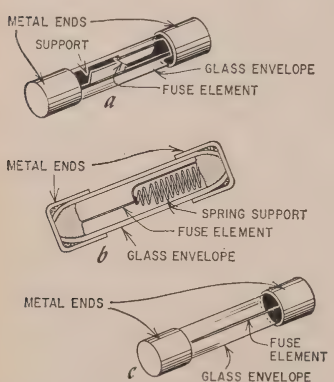


Fig. 1-a—Instrument fuse with anti-vibration mounting. b—Another type of anti-vibration mounting. c—Larger amperage fuses do not need anti-vibration mountings except in special applications.

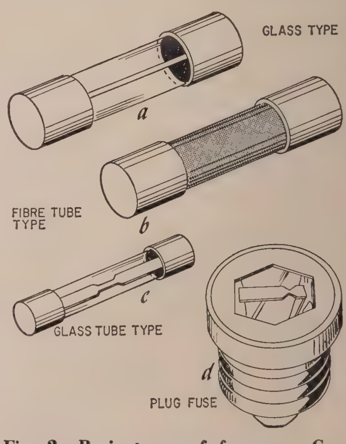


Fig. 2—Basic types of fuses: a—Cartridge type with glass envelope and wire fuse link. b—Cartridge type with fibre envelope. c—Cartridge type with ribbon element. d—Plug type with ribbon element.

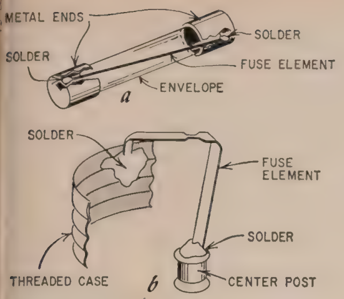


Fig. 3—Internal assembly of fuses. a—cartridge type; b—plug type.

designed to protect delicate meters and instruments. It is usually made only in values between 1/500 and 2 amperes. These fuses will carry their full rated current without opening, but a 200% overload will cause them to open in less than 5 seconds. Greater overloads will make them open even faster. For example, a 500% overload will open a fast-acting fuse in 3/100 second.

The smaller instrument fuses (1/500- to 1/32-ampere units) have extremely fine elements—some can barely be seen with the naked eye. Therefore they are supported bridge-fashion to protect them against vibration. Sudden shocks would snap such a fine element if it were not supported. The construction of this type of fuse is detailed in Fig. 1-a. In Fig. 1-b another type of anti-vibration mounting is shown. The 1/16- to 2-ampere sizes are illustrated in Fig. 1-c.

When we come to the standard types, we find a variety of sizes and shapes. Typical units are shown in Fig. 2. All of these are usually rated to carry 110% of their rated current without opening, yet will open in less than 1 hour if current goes up to 135% of the rated value. Again, greater overloads will blow the fuse much sooner, within fractions of a second in some instances.

The two major types of standard fuses are plug types (like those you use in your fuse box at home) and cartridge types that have either a glass, fiber or bakelite case. The elements are either a single wire or a flat ribbon (Fig. 2). In cartridge types this element is supported at each end (Fig. 3-a), while in plug types the mounting is a little more complicated (Fig. 3-b).

The amazing things about these fuses are the things not generally known. For example, let's take a plug type fuse that has just been subjected to a severe overload. The intense heat caused by the excessive current turns the fuse link into white hot gases under tremendous pressure. Naturally, there must be a safe way for these gases to escape. One manufacturer handles this problem by making the top cap of its fuse act as a valve (Fig. 4). The hot gases spread out along the mica window in the top of the fuse and escape through tiny notches under the edge of the top cap. This cools the gases and allows them to discharge safely.

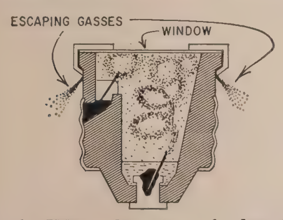


Fig. 4—When this type of plug fuse blows, gas escapes through vents around the cap.

Now to one of the most interesting of all, the slow-blow or delay fuse. The thing that makes these units so fascinating is that they work in a variety of ways although they all do the same thing. Basically, a delay fuse will tolerate a certain amount of overload and do so intentionally. However, if the overload continues for an excessive period of time, the fuse opens. Also, a delay fuse will blow almost instantly if the overload is many times too great.

These fuses are often used where motors (air conditioners, refrigerators, etc.) are in circuit, since such devices often draw starting currents several times greater than their running current. For example, a 7.5-ampere air conditioner needs a 15- to 20-ampere standard fuse to tolerate its tremendous starting current. But if the motor didn't start, it would draw enough current to burn out but not enough to open the fuse.

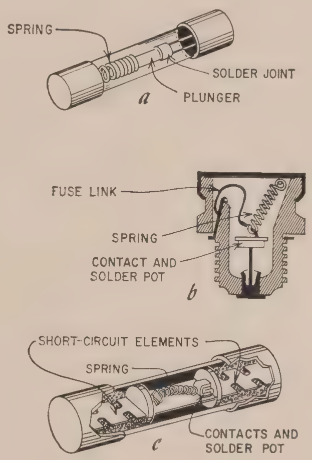


Fig. 5—Construction of various types of slow-blow and time-lag fuses.

When you use a slow-blow fuse, however, a 10-ampere unit will take the starting surge of 15 to 20 amperes without blowing but, if this surge doesn't taper off within a reasonable time, the fuse will blow. This could happen if a starting capacitor shorted.

In some of the older TV receivers, slow-blow fuses were used to protect the high-voltage circuits. These sets developed transient pulses that would blow a standard fuse. By using a slow-blow fuse, however, the set manufacturer got a delay that was long enough to keep the fuse from blowing because of transients, as well as protection against severe shorts. So in a TV receiver, never replace a slow-blow fuse with a standard type or you'll probably find yourself coming back again because of a blown fuse, even when there is no trouble in the circuit. Conversely, if you are having trouble with standard fuses blowing, don't substitute a slow-blow fuse. These will not protect the circuit properly and could result in a flyback burnout because a shorted damper tube didn't blow the fuse in time to save the flyback.

Now, we've seen where slow-blow fuses are used, and why. But just how do slow-blow fuses work?

Three kinds of slow-blow fuses are shown in Fig. 5. The first (Fig. 5-a) is a cartridge type. An overload heats up the solder that holds the contacts together. If the overload doesn't last too long, the solder cools and everything returns to normal. However, if the overload doesn't clear up, the solder melts and the spring pulls the contacts apart, opening the circuit. If there had been a short in the circuit, the fuse element would have vaporized—just as it would in standard fuses—before the solder even got a chance to warm up.

The fuses shown in Fig. 5-b and -c work in the same fashion; the only difference is in their design. Fig. 5-b shows a plug type fuse and Fig. 5-c is what is termed a time-lag fuse. Such a unit is designed to give a long time delay for special applications.

Special types

Another group of interesting fuses are the indicating types. These units let you know when they have burned out or opened. In some (Fig. 6-a), a little plunger comes out the end, or the top (Fig. 6-b). Other devices can be added to these fuses so that, when they open, the plunger will close a switch to turn a pilot or warning lamp on or off. Or, as one manufacturer is doing, simple attachments may be added to almost any type of fuse, to light when the fuse blows. These units are shown in Fig. 6-c. Indicating fuses are most often found where a large number of fuses are mounted on a single panel. Here they become necessary if a blown fuse is to be found easily and quickly. Therefore, they are commonly used in industrial and military applications.

FUSE IDENTIFICATION
Cartridge Types

LITTELFUSE TYPE	BUSSMAN TYPE	DIMENSIONS (INCHES) DIAMETER	LENGTH
1AG	AGA	1/4	5/8
3AG	AGC	1/4	1 1/4
3AB	ABC	1/4	1 1/4
4AG	AGS	9/32	1 1/4
4AB	ABS	9/32	1 1/4
5AG	AGU	13/32	1 1/2
7AG	AGW	1/4	7/8
8AG	AGX	1/4	1
9AG	AGY	1/4	1-7/16
SFE	SFE	1/4	Varies According to Amperage

Five types of cartridge fuses made by Littelfuse.

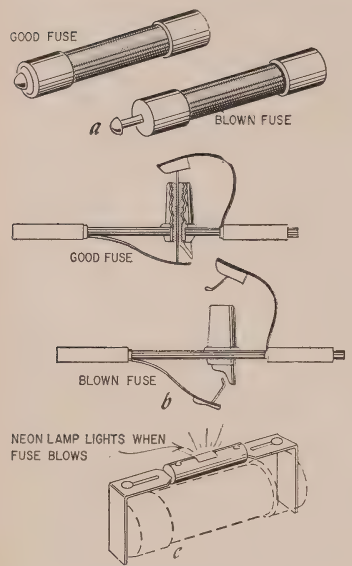


Fig. 6—Special types of fuses: a—Pin comes out end of indicating fuse when it blows. b—Grasshopper fuse springs apart, gives positive action. c—Another type of indicating fuse.

Still another special type fuse is the grasshopper. It has already been shown in Fig. 6-b where its application as an indicating fuse was shown. But even more important is its action when it blows. The two leaflike elements spring apart, giving a quick-acting fuse that is practical for high voltages. The spring action pulls the broken ends of the fuse so far apart that no arcing can occur across the gap.

Another type of fuse is the fusable resistor found in many recent-model TV receivers. This unit is a wirewound resistor with some specific ohmage rating—somewhere between 5 and 13 ohms. It provides two types of protection. It acts as a series resistance that protects rectifiers in the set against sudden voltage surges, and it acts as a slow-blow fuse for overloads. The unit is actually a wirewound resistor, but one that will burn out if the set draws excessive current.

A rather different type fuse is the chemical fuse. To date it is used by only one manufacturer (RCA), to protect the B-plus circuit of TV receivers. It looks like a standard cartridge fuse in size and shape, but instead of a glass cylinder surrounding the fuse element, there is a ceramic jacket. The fuse element itself is a metal wire covered with a special chemical coating. When it is in the B-plus circuit of a TV receiver, it passes current just like any other fuse. If the damper cathode arcs over momentarily, the short surge starts to heat up the wire in the fuse but doesn't last long enough to have any effect. (This same transient would burn out a standard ¼-amp fuse.) However, if there is a short that exceeds the current rating of the fuse and lasts longer than a few instants, the wire in the fuse gets hot enough to set off the chemical coating and the fuse element disintegrates. (This action is much faster than that of a slow-blow fuse and therefore provides greater protection.)

Fuse identification

There are two major manufacturers of fuses in the US today—Littelfuse and Bussmann. These companies use different codes to identify their fuses. For the technician who may run into a Littelfuse and has only Bussmann replacements, or the man who runs into a Bussmann fuse and has only Littelfuse replacements, we have listed both makes in a table that shows equivalent units.

When replacing fuses, an important factor is physical size. In automotive fuses, for example, only one amperage fuse will fit in a particular fuse holder since each amperage fuse is a different length—the higher the current rating, the longer the fuse. However, for other applications, many fuses will all have the same length. For example, in the 3AG series, all fuses are the same length, no matter what current rating they have. Also, the 20-amp auto fuse is the same length as all the 3AG fuses.

Therefore, when replacing fuses, always be sure that you are using a replacement whose voltage and current ratings are identical to those of the fuse that blew. And remember, if a fuse keeps blowing, something is drawing too much current—don't replace the blown fuse with one that has a higher current rating. It may not blow, but your wiring may overheat and start a fire. Or in a TV receiver you'll lose a $10 flyback transformer instead of a 25-cent fuse.

So where do we use the many types of fuses we have surveyed? Quick-acting units go into that expensive voltmeter or other delicate test instrument that small overloads may damage. The slow-blow types go wherever short surge currents are normal and where a standard fuse would blow, even though there is no fault in the circuit. And standard fuses are used about everywhere else.

But to play it safe, whenever you replace a fuse, use one that has identical ratings to the one that blew and you can't go wrong. You can track down a dead short with an ohmmeter; a slight overload will call for checking the parts that draw current off the line by removing them one at a time. When the current drops to normal upon removing a particular part, you know that it is the defective one. So don't take that little glass tube or screw-in device for granted. Use it properly and it can be a lifesaver.

Thanks to Bussmann Manufacturing Div., Littelfuse Inc., and the Sight-master Corp., for supplying much information. END

Bussmann makes this assortment of fuses.

Table-top instrument gives you a continuous check on CB transmitter operation

Modulation monitor checks CB transmitters

By LYMAN E. GREENLEE

HERE is an essential piece of test equipment for anyone planning to work with Citizens band transceivers.

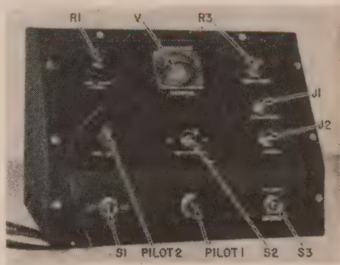
This is what it is:

- A dummy antenna that loads the transmitter for off-the-air testing.
- A tuning indicator, with resonance shown by electric eye, milliammeter and pilot bulb.
- A modulation monitor, with provision for listening to the transmitter output through headphones.
- A modulation percentage indicator.
- An rf output indicator.
- An af output indicator.
- A carrier-shift indicator.
- A convenient means for coupling an oscilloscope to a transmitter.

Good clean speech is rare on the Citizens band. Blasting, distortion, phase shift, hum and poor frequency response are common difficulties with transceiver transmitters. Unless the operator has some way of monitoring his own transmissions, he may never know how bad he sounds on the air, and will continue to blast away with a scarcely readable signal. Modulation troubles may be within the transceiver or be caused by ignorance of proper mike technique, use of a microphone with poor frequency response, a defective installation, antenna or power supply. Regardless of where the trouble may be or what is causing it, there is no easy way to locate the difficulty without monitoring the transmitter signal.

All Citizens-band transmitters should be checked out off the air. The trans-

R1—pot, 20 ohms, 3-5 watts, wirewound
R2—1,000 ohms, 1 watt
R3—pot, 1 megohm, linear taper; screwdriver adjust
R4—16,000 ohms, 1 watt, 1%
R5, R6—1 megohm, ½ watt
R7—3,300 ohms, ½ watt
R8—470,000 ohms, 1 watt
R9—10,000 ohms, 2 watts
R10—270 ohms, 1 watt
R11—100 ohms, 1 watt
C1—4-30 μμf, ceramic trimmer
C2, C4—.001 μf, mica
C3—12 μμf, ceramic
C5—470 μμf, mica
C6, C7—.05 μf, paper, 200 volts
C8, C9—10 μf, 450 volts, electrolytic
C10—330 μμf, mica or ceramic
D1, D2—1N75
J1—phone jack, open circuit (Switchcraft type 11 or equivalent)
J2—phone jack, closed circuit (Switchcraft type 12A or equivalent)
L1, L2—rf transformer; coils cut from B&W Miniductor. Use one type 3011 and one type 3015 cut as described in text
PILOT 1—indicator light assembly with No. 40 bulb (Dialco M-432, Series 810 or equivalent)
PILOT 2—indicator light assembly with No. 40 bulb Dialco type 504 socket or equivalent)
PL—Phono plug or other connector to match transceiver.
RECT 1, RECT 2—selenium, 130 volts, 50—65 ma
RFC—21 μh (Ohmite Z-28 or equivalent)
S1—spst toggle switch
S2, S3—dpdt toggle switches
T1—power transformer; primary, 117 volts; secondary 250 volts, 25 ma, ct; 6.3 volts, 1 amp (Allied Radio 62 G 008 or equivalent)
T2—audio transformer; 1:1 ratio (Philco 32-7484, Stancor A-4711, Thordarson 20A29 or other Small 1:1 transformer)
V—6AL7
Tuning-eye assembly for V (Amphenol 58-MEA-8)
Terminal strips, 6 lug (5)
Terminal strip, 3 lugs (1)
Grommets, ½ inch (2)
Grommets, ⅜ inch (4)
Grommets, ¼ inch (3)
Length of 72-ohm line (3 feet)
Case, 6½ x 9 1/16 x 7 5/16 inches with sloping front (Bud C1585 or equivalent)
Chassis, 7 x 7 x 2 inches
Miscellaneous hardware



The finished instrument in its crinkle-finish case.

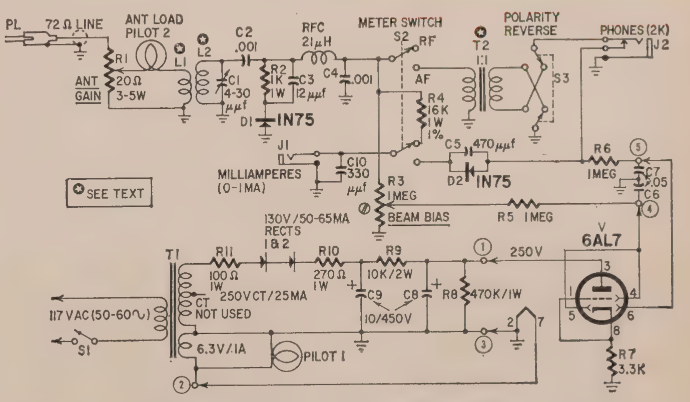
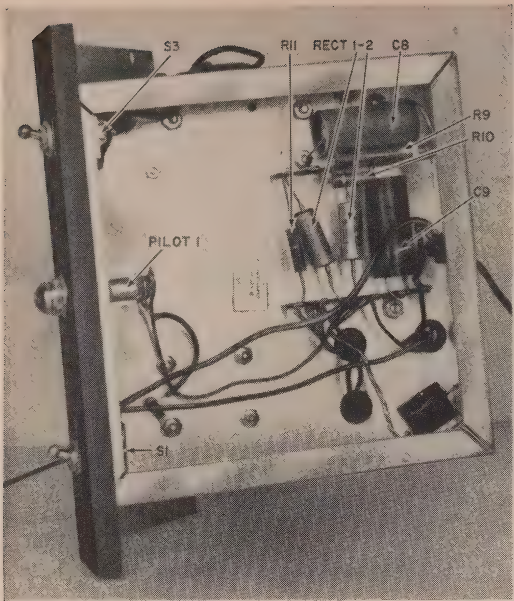
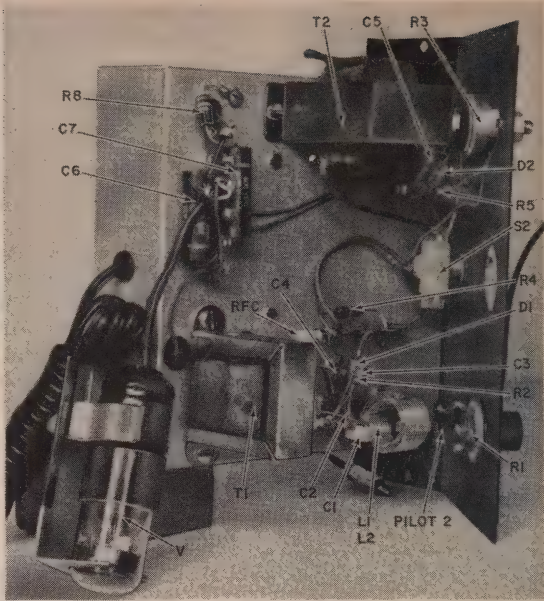


Fig. 1—Circuit of the modulation monitor.



Most underchassis parts are mounted on terminal strips.



Top chassis view shows parts arrangement.

mitter must work into a dummy antenna to be properly loaded and prevent interference from being radiated to other stations. A pilot light is the usual dummy-antenna load resistance. The modulation monitor combines the pilot light with a modulation indicator and tuning meter.

The transceiver under test is coupled to the monitor through a length of 72-ohm line. The rf signal feeds directly from the transmitter through an attenuator to drive a diode detector whose output is used to indicate either rf or af output on any milliammeter (which may be a part of other test equipment).

To check percentage of modulation, the signal is fed through a 1-to-1 ratio transformer to remove the unmodulated rf, and the af component is again rectified to separate the positive and negative signal peaks. Both af and rf signal levels can be measured on the same meter by flipping S2 (Fig. 1), and the af meter reading will be in percentage of modulation when the input is adjusted so the rf reading is exactly 1 ma. S3 is a polarity reversing switch for checking relative values of upward and downward modulation peaks. The 6AL7 tuning eye is a double-target tube designed primarily for FM tuners. The two separate targets are coupled to the rf and af outputs so both may be simultaneously monitored on the tuning-eye screen.

How you build it

The monitor is assembled on a 7 x 7 x 2-inch aluminum chassis, fitted in a metal cabinet with sloping front. The panel layout and chassis hole location are shown in Figs. 2 and 3. If parts substitutions are made, arrange the parts on the chassis and outline them in pencil as a guide for drilling the mounting holes. While parts layout is not critical, the af transformer and wiring must be kept well away from all components and wiring carrying rf. The front panel is not fastened to the chassis until all parts are mounted and most of the wiring has been finished.

Assemble and wire the power supply under the chassis first. An isolation

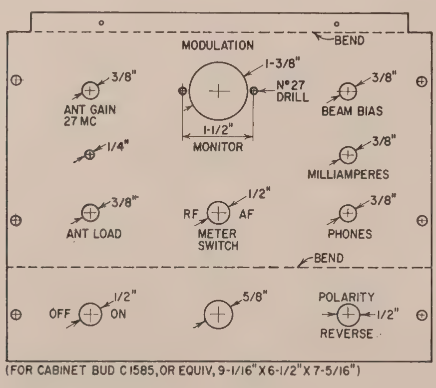


Fig. 2—Front panel layout for slope front cabinet.

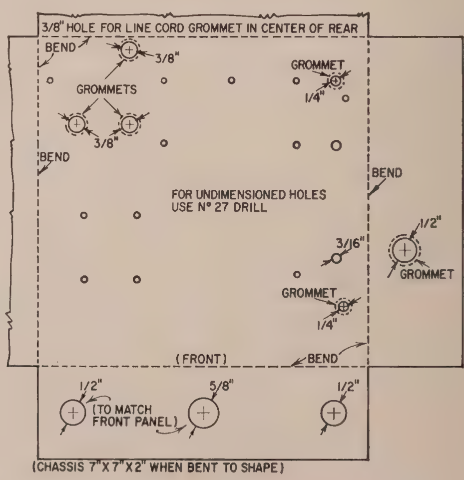


Fig. 3—Chassis layout for the modulation monitor

transformer and selenium rectifiers furnish the 250 volts dc for the tuning eye, and also the 6.3 volts for the 6AL7 filament and the pilot light. Leads from the power transformer are pulled through the three holes insulated with ⅜-inch rubber grommets. The rectifiers, resistors and capacitors are supported on two six-lug terminal strips. (If the selenium rectifiers are the bolt-mounting type, stack and fasten them to the chassis with a single bolt.) Resistors R10 and R11 protect against voltage surges and act as fuses if the selenium rectifiers should ever short. If the plate voltage on the 6AL7 exceeds 250 after tube warmup, decrease the value of R8 and, if necessary, increase R9 to 15,000 ohms.

Disassemble the Amphenol socket and cover for the 6AL7 tuning eye, and check the connections. Modify the wiring to conform to Fig. 1. Wire the tuning-eye assembly along with the rest of the chassis, but do not install it on the front panel until all other assembly and wiring is finished. Since the front panel is held to the chassis by the pilot light and switches S1 and S2, temporarily fasten these parts to the front of the chassis until you are ready to attach the front panel.

Transformer T2 may be any small 1-to-1 ratio audio transformer or isolation transformer. A 2-to-1 ratio push-pull audio driver can be used if half the winding is used to get the required 1-to-1 ratio. Pull two leads from S3 up through the ¼-inch grommet in the top of the chassis and allow enough length to reach J2 after the front panel is installed. T2's secondary leads are dressed through the ½-inch rubber grommet on the side of the chassis and pulled up to S3. Allow enough slack on these leads to permit moving S3 while the front panel is being fastened in place.

Tuning coil L2 is 10 turns cut from a B & W Miniductor form, type 3015, and L1 is 3 turns cut from a type 3011 form. Slip the 3-turn antenna section inside the larger coil and fasten it in place with a few drops of polystyrene cement. As shown in the photographs, L2 and the other components of the rf portion of the monitor are supported from the chassis on a pair of 6-lug terminal strips. A 4–30-$\mu\mu$f ceramic padder tunes L2 to the 27-mc band. Tuning is not critical and the padder may be set for the middle of the 27-mc band and left alone.

Wire the components on the front panel before attaching it to the chassis, and leave leads long enough to reach chassis components. Connect the 3-foot length of 72-ohm line directly across the 20-ohm potentiometer. Run a short length of wire from the center tap of the potentiometer to the No. 40 pilot-lamp socket and attach a length of wire from the ground side of the 72-ohm line to the base of coil L1. Note that in wiring the rf section, all ground connections are made to a common point—the base of L1—and all leads carrying rf are kept as short as possible and completely away from the af portion of the circuit.

A phono plug is shown as the antenna connector in Fig. 1 since many Citizens-band transceivers use this type of connector. Of course, if your set has a different type connector, use a plug to match the antenna jack on the transceiver. If there is any indication of body capacitance effects when adjusting R1, run a separate ground wire from the chassis of the monitor to the chassis of the transceiver.

Fasten panel and chassis together after completing the wiring on both. Connect the remaining leads between them, install the tuning eye, and the job is finished and ready for testing. For a preliminary check, plug in the line cord, measure the 6AL7 plate voltage (change resistors if above 250 volts) and observe the pattern on the 6AL7 screen. If a grid-dip meter is handy, set it to the 27-mc band and couple closely to L1. Adjust padder C1 for resonance, and adjust R5 to deflect the tuning-eye beam. Now plug the 72-ohm line into a transceiver antenna jack. Set R1 at about half-scale. Set S2 to RF. Plug an 0–1-ma meter into J1. It will be convenient to make a set of test leads for this purpose out of a phone plug, length of lamp cord and a couple of plugs that will fit the pin jacks on the meter to be used. With the milliammeter connected (observe correct polarity) and the transceiver set to transmit, the meter should read slightly less than full scale. Adjust padder C1 for maximum reading; then adjust R1 until the meter reads full scale on rf. Now flip S2 to AF. The meter reading should drop to almost zero, but should rise sharply when you speak into the microphone. If the RF reading was carefully set at exactly 1 ma (full scale), the meter reading in the AF position will be directly in percentage of modulation—a full-scale reading of 1 ma being equal to 100% modulation.

Now plug a pair of 2,000-ohm headphones into J2 and you can monitor speech from the transceiver. Since it is difficult to judge the quality of one's own voice, have someone else talk into the mike while you listen to the quality, or connect a tape recorder to the phone jack and record your voice from the transceiver. Listen to the recording and try to correct errors in mike technique.

For a correct meter reading on AF, the headphones must be removed. One side of the 6AL7 pattern will indicate audio modulation and flicker as you talk into the mike. Adjust R3 so the other side of the pattern is almost closed when the meter reads full scale on RF. Due to the load of R1 across the 72-ohm line, the No. 40 pilot bulb in the antenna circuit will not glow as brightly as it would if used alone as a dummy antenna. With R1 at maximum, the bulb should light with about half the brilliance obtained with a direct connection to the transceiver antenna jack.

If the transmitter output is pure unmodulated rf, there should be no sound in the phones and no AF reading on the meter. There will usually be a small amount of signal caused by hum and random noise in the carrier. By listening to the output, this residual reading can be identified as either noise or hum and corrective measures can be tried if it is excessive. Check with the mike removed and mike input terminals shorted.

If an oscilloscope is available, you can calibrate the modulation monitor. Connect the scope as shown in Fig. 4 to get a modulation pattern from the transmitter.* Feed an audio signal, preferably from an audio generator, into the transmitter mike input and set

*For a more complete discussion on using the oscilloscope to check AM phone operation, see the current issue of *The Radio Amateur's Handbook*, published by the ARRL.

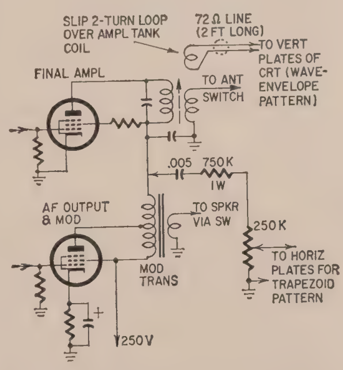


Fig. 4—Calibrate monitor with a scope by comparing scope patterns with monitor readings.

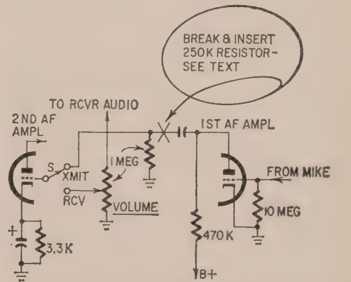


Fig. 5—How to cut gain to reduce modulation, if necessary.

the level for 100% modulation as observed on the scope. With the meter set to read full scale on rf, the af component should also read full scale. If the af component of the modulated signal does not read the same as the rf component, change R4 to a value that will give the correct reading. By adjusting R1 to reduce the gain, the meter can be made to read half-scale on RF, and this half-scale reading should be compared to the reading on AF with 100% modulation as a further check of accuracy before making any change in R4. Both readings should be the same for 100% modulation.

The scope's vertical amplifier can be connected to the monitor in place of the phones to display voice patterns from the transmitter. Any audio signal fed into the mike input of the transceiver will appear as a corresponding pattern on the scope screen and can be used as a basis for making an overall check of the frequency response of the transmitter, limited of course to any distortion that may be introduced by T2. By running checks on transceiver transmitters known to be good, the operator can learn the type of pattern to be expected on the screen, and the amount of distortion introduced by T2 and the scope's vertical amplifier.

S3 is a polarity-reversing switch that enables observation and checking of both positive and negative modulation peaks. Under ideal conditions, reversing the polarity with S3 would make no difference in meter reading (AF). However, under normal modulation conditions the positive and negative peaks will not be exactly equal and there will be a slight difference in the meter reading. Any substantial difference in meter reading when the polarity is reversed indicates some defect in transmitter modulation. There is probably a shorted turn in one winding of the modulation transformer.

With S1 in the RF position, a fluctuating meter reading when the transmitter is being modulated indicates carrier shift that is usually caused by a nonlinear distorted modulation amplifier. Under normal modulation, the carrier reading (RF) should remain steady for a modulated signal. At modulation levels approaching 100%, there will be some carrier shift in most transceivers. Modulation level should be set at a level that never exceeds 95%. If the modulation is over 100%, usually all that is necessary is to reduce the gain in the speech amplifier to a level that allows a maximum of 95% modulation. Because of the varying sensitivity of different microphones, it is easy for a change of microphones on a transceiver to alter the modulation level and force it over the 100% point. A 250,000-ohm resistor in series with the coupling capacitor to the grid of the second audio stage in the speech amplifier is usually all that is needed to cut the gain to an acceptable level (Fig. 5). The added resistor may be any value necessary to reduce the level to the point where there is no blasting or overloading. Try values between 50,000 and 250,000 ohms. END

WHAT'S YOUR EQ?

We are starting this month a department of mental calisthenics—an opportunity for you to see just how fast your brain can turn corners. So that everybody can have a chance, the exercises are graded into three groups. The first will be practically on the engineering level, the second something for the good practising TV technician and the third for the beginner.

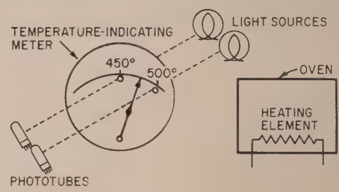
Next month we will publish possible solutions to the first two questions, plus the answer to the third.

Since the first two problems will probably have more than one good solution—there are more ways than one to lick a design problem, and a single set of symptoms in a TV set may have more than one cause—we are asking our readers to send in what they consider the best solutions for the first two. Mail your answer to Puzzle Editor, RADIO-ELECTRONICS, 154 W. 14th St., New York 11, N.Y.

RADIO-ELECTRONICS invites its readers to send in their own *original* brain-teasers. We will pay $10 for each one used.

Photo-relay circuit

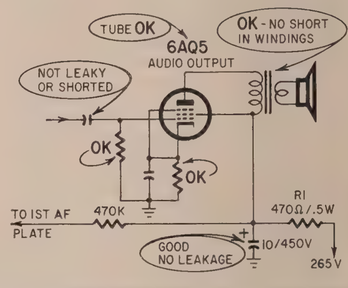
TWO photo-relay circuits are to be used to maintain the temperature of an oven between the limits of 450° and 500°. The phototubes are illuminated through two openings in the temperature-indicating meter of the oven as shown in the drawing. The oven is heated by a 117-volt heating element which should turn *off* when the meter pointer blocks the opening at 500°, and turn *on* again when the pointer drops back to 450°. The 50° *dead zone* is used to limit the number of relay operations per hour (which would be much higher in a single phototube system). What circuit arrangement will provide the desired temperature regulation without requiring any manual controls except an on–off switch in the power line? The circuit must work from a "cold" start when the pointer of the meter is still below the 450° level.—*Ed Bukstein*



Service Stinker No. 1

SYMPTOMS: No picture. Slight hum in sound. Resistor R1 burns out immediately. ½-watt size is correct; other sets work with this value. Dc voltages normal. No shorts to ground. Tubes all replaced.

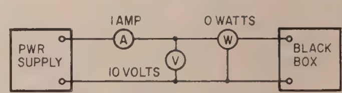
QUESTION: What is burning R1 out in such a hurry?—*Jack Darr*



Black Box

THIS is one of the classics among the simple problems. It requires knowledge of only the most fundamental laws, and can have but one answer. Yet it is very tricky for the person who is not looking for that one answer.

A black box is connected to a power source that supplies it with 10 volts and 1 ampere, as indicated by a conventional voltmeter and ammeter. Yet an equally conventional wattmeter also connected across the input of the black box shows that *no power* is being supplied to the load. What is in the black box? END



COMMUNICATIONS ON 450,000,000 MC

The optical maser is a source of coherent, monochromatic light. By modulating and amplifying this coherent light emission, it will be possible to use light as radio waves are used today. Until now, there were coherent sources of electromagnetic waves only for frequencies less than 10^5 mc (10^{11} cycles) (Fig. 2). The optical maser has raised this limit almost 10,000 times. And not only has the frequency been increased but the sharpness—or fractional bandwidth—has also been improved.

COVER STORY

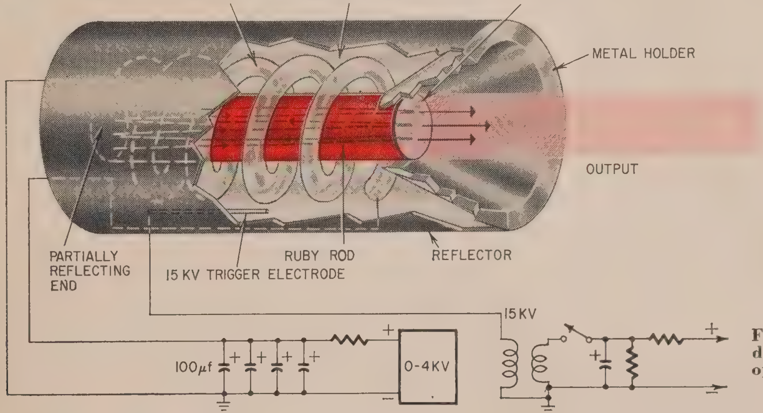


Fig. 1—Basic diagram of the optical maser.

By R. J. COLLINS and D. F. NELSON

MASER STANDS FOR MICROWAVE AMPLIfication by stimulated emission of radiation. Following the proposal by Prof. C. H. Townes of Columbia University and Dr. A. L. Schalow of Bell Telephone Laboratories to extend the maser principle from the microwave region to the optical spectral region, some people have used the acronym *laser*, the letter *l* standing for light. But since the principles are the same in both cases, the tendency simply to say "optical maser" is growing.

The ruby optical maser as reported by Bell Telephone Laboratories and similar to the Hughes Research Group's development consists of a Linde synthetic pink ruby rod 0.20 inch in diameter and 2 inches long. Both ends of the rod are optically polished to make them flat within 2×10^{-6} inches and parallel to within 10 seconds of arc. The end surfaces are made partially reflective, allowing only about 5% of the light striking them to pass through.

A source of input power, a xenon-filled flash lamp, surrounds the ruby rod. It is pulsed by discharging a bank of capacitors through it. Charged to 4,000 volts, the bank delivers 3,000 joules to the lamp in about 1 millisecond.

Fig. 1 shows both the mechanical and electrical details of the construction of a pulsed-ruby optical maser. In the bottom section is a 0–4,000-volt power supply, used to charge the bank of four 100-μf 4,000-volt capacitors. The series resistor limits the charging current. Also shown is the supply for the 15-kv transient that triggers the FT524 flash tube.

A funnel-shaped cone holds the ruby rod axially within the helical coil of the flash tube. Surrounding the entire

assembly of holder and lamp is a reflector. It can be either highly polished aluminum sheet or powdered magnesium oxide. It contains the flash-lamp output so a large fraction of it will be absorbed by the ruby. The ouput of the flash lamp is white light but only the green and violet portions of it can be absorbed by the ruby.

Besides the essential parts—ruby, flash lamp and reflector—a coolant for the ruby and flash tube, and opaque shields surrounding the exterior parts complete the maser.

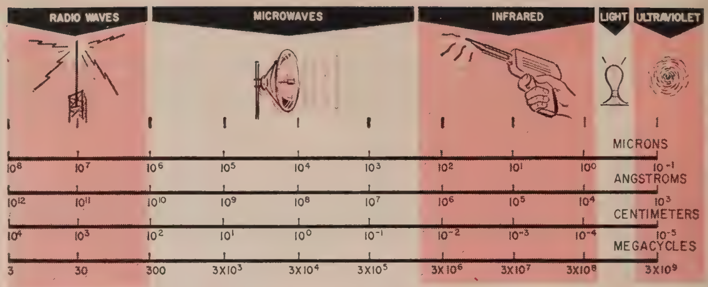


Fig. 2—Frequency spectrum shows relationship of electromagnetic waves.

Atoms and radiation

Why a maser—optical or microwave—operates can be understood with the help of Fig. 3. This drawing shows the interaction of an atomic system and radiation. Fundamentally, the only difference between microwave masers and the new optical ones is the spacing between the energy levels. In the microwave maser, these levels are separated only 1/10,000 as far as in the optical maser.

All atomic and molecular systems have their electrons in such discrete and separate energy levels. "Discrete and separate" means that only certain amounts of energy can be stored by the electron in atoms or molecules. An electron can increase its energy by absorbing, from an electromagnetic wave striking it, an amount of energy just equal to the difference between two levels. Conversely, it can decrease its energy by emitting a photon—a pulse of electromagnetic radiation equal in energy to the spacing between two levels. The frequency of the radiation emitted in such processes is proportional to the energy.

Normally, in an atomic system, the electron is in the lowest energy level or ground state. If an electromagnetic wave (photon) strikes the system (Fig. 3-a), the electron absorbs the photon energy. But if the system has been prepared (by applying energy from some outside source) with more electrons in excited states than in the ground state, a wave would not cause absorption, but rather would cause the *emission of radiation*. This process is called stimulated emission (Fig. 3-c) to distinguish it from spontaneous emission.

Spontaneous emission is the kind that occurs when the excited electron emits energy and decays to the ground state without the help of an incident wave (Fig. 3-b). Spontaneous emission is important in a maser since it is the dominant loss mechanism. That is, the input power must be greater than the stimulated emission before maser action can occur. For maser operation, a system is prepared so that more electrons are in an excited state than in the lower state. A light wave passing through the atom then stimulates emission and thus is amplified. (When a system has more electrons in an upper excitation state than in a lower state, it is said to have an *inverted population.*

Ruby, which is crystalline aluminum oxide (Al_2O_3), with chromium atoms substituted for some of the aluminum atoms, has a set of energy levels well suited for use as an optical maser. This particular set of levels is for an electron attached to the chromium ion (Cr^{+++}). It is the absorption of green and violet light by these ions that gives ruby its familiar red color.

Fig. 4 shows the steps whereby the absorption of green and violet light can be used to create an inverted population. Electrons, excited by the absorption of green or violet light, are driven from the ground state to the higher excited states shown in the figure as solid rectangles. From these highly excited levels the electrons fall rapidly to the lowest excited energy state giving some energy to the crystal lattice in the process. This lowest excited state has a long lifetime for spontaneous decay (about 3 milliseconds) and is therefore called *metastable* (comparatively stable). From the metastable level, the electron drops to the ground state, radiating energy as red (6943Å) light.

A large number of the Cr^{+++} ions in ruby can have ions in the metastable level when a strong green light shines on the crystal. If electrons arrive in the metastable state faster than they return to the ground state, the electron population will become inverted. The xenon flash lamp is an intense enough source of green and violet light that more than half of the Cr^{+++} ions have their electrons in the metastable level for short periods of time.

When the Cr^{+++} ions are in an "inverted-population" state, red light passing through the ruby will stimulate emission and thus be amplified. To make an oscillator, the flat ends of the ruby rod can be made partially reflecting, allowing some light to be fed back and further amplified.

Let us now examine in detail the operation of the oscillator. After the inversion is accomplished through the excitation provided by the green light, the excited electrons begin to return to the ground state by emitting red light. Most of this light, being emitted as spontaneous emission, will be lost, since it is emitted in all directions, and any light striking the sides will leave the crystal.

A small part will be emitted along the axis of the ruby cylinder. This small part, while traveling down the crystal, will *stimulate* more radiation by interaction with the excited electrons in the Cr^{+++} ions. The stimulated emission is directed along the axis of the cylinder. With growing intensity, the light wave moves down the ruby crystal and finally strikes the reflecting end. These ends allow approximately 5% of the light to escape from the crystal. The other 95% is reflected to make another pass through the crystal. On this, as well as along succeeding passes, it will stimulate emission and be amplified. In this sense, the process is analogous to a regenerative radio-frequency circuit, where part of the energy is fed back to produce still more energy. The red-light output of a ruby maser is an electromagnetic wave at 4.3×10^8 mc.

As a result of passing the light back and forth between the end plates in the oscillator, standing waves of the light are set up the crystal. The emission stimulated by this standing wave will then have the same phase across any section of the rod, including the partially reflecting end plates. It will be *coherent* across the end faces. Since the radiation transmitted through the ends (the 5% not reflected) consists of a single phase, directional beams are possible.

Normal radio or radar antennas may be several hundred wavelengths wide and have beam widths of several degrees. The optical maser is about 10,000 wavelengths across and has a beam width of .01°. This property of coherence, therefore, makes possible a very directional beam.

The extremely narrow cone of emission is remarkable particularly when compared to a normal light source. The radiation from all other light sources is emitted uniformly in all directions (even in the maser rod itself the spontaneous portion of the emission is so radiated) while only the maser emission is confined to the narrow cone. Some idea of the cone width can be obtained from the experimental results obtained by the Bell Telephone Laboratories group. They observed that light from the maser covered a circle about 200 feet in diameter at a distance of 23 miles.

The frequency bandwidth of an optical maser is much narrower than the bandwidth of the spontaneous radiation from the same material. At room temperature (300° Kelvin) the spontaneous decay of electrons from the metastable level (Fig. 4) in ruby to the ground gives an emission with a width between the half-power points of 3A.

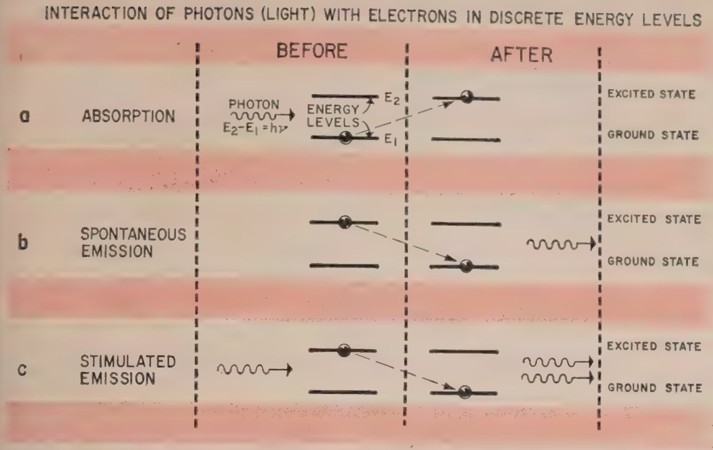


Fig. 3—Interaction of an atomic system and radiation: a—Absorption; b—spontaneous emission; c—stimulated emission.

or 1.8 × 10^5 mc. When maser action begins and the decay is dominated by stimulated emission, the width decreases by a factor of 100. This decrease in line width results from the feedback employed in the maser. The analogous situation in electronic circuitry—where positive feedback may be used to sharpen selectivity in a communications receiver, or unwanted regeneration may ruin the response of a television or FM if stage—is well known.

The pulsed ruby maser is the most powerful monochromatic light source now available. In a bandwidth of 6 × 10^2 mc, ruby optical masers generate about 1 kw. By comparison, the standard high-purity light sources available in the past, such as the mercury arc, would emit only fractions of a watt in a comparable bandwidth. Furthermore, in such sources the energy was emitted nearly uniformly in all directions—the optical maser light is confined to a narrow cone.

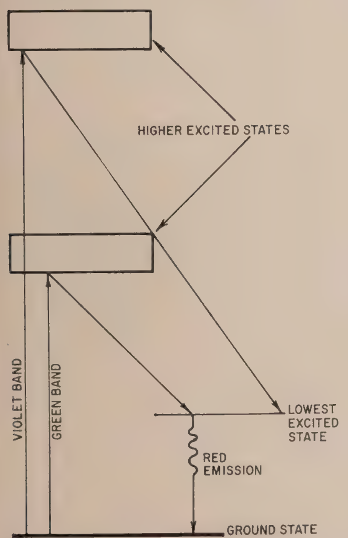


Fig. 4—Steps whereby absorption of green and violet light can be used to create an inverted population.

A good way of thinking about the brightness of a radiation source is in terms of its temperature. The sun has an apparent temperature of about 6,000°K, and within a bandwidth comparable to that of the ruby maser emits about 1/20 watt per square centimeter. Masers emit kilowatts/cm². Moreover, the sun radiates its energy in all directions, while the maser does not. For the sun to radiate as much optical power within the same frequency limits and solid angle as the ruby maser, its temperature would have to be 10^{10} °K.

An unexpected discovery during the development of the ruby maser was that the output was not continuous. The output consists of a series of short bursts of emission during each pulse. Relaxation oscillations were obviously taking place.

Two other masers

Soon after the development of the first optical maser, two more pulsed masers were announced by the International Business Machines Corp. (IBM). Both the new masers used calcium fluoride as a host lattice. When the rare-earth element samarium was added to the CaF_2 crystal in small amounts, maser action was observed at 7,020 Å, or 4.21 × 10^8 mc. It is also possible to include small amounts of uranium in crystals of CaF_2 during growth. The uranium causes a spontaneous fluorescence in the infrared (1.21 × 10^8 mc) which has allowed a maser to be operated at 2.49 microns. Both of the masers using CaF_2 have been cooled below 20°K when operated.

Although these masers—like the ruby—are operated in a pulsed manner, in the future continuous operation should be possible. This possibility results from the much lower power needed to produce an inverted population. The fluorescent transition does not involve return to the ground state as in ruby. It is a transition between two excited states. Therefore, to obtain an inverted population it is not necessary to excite half the total atoms as in ruby, but only a small fraction of them. At present, the solid-material optical masers have all been pulsed.

The Bell Telephone Laboratory has recently observed optical maser action in dark red ruby, which has a higher chromium content than the pink type. The increased Cr^{+++} content introduces new energy levels, which are used in the new maser. Optical maser action in the dark red ruby is at 4.28 and 4.26 × 10[illegible] mc.

A gas maser

The first optical maser to operate continuously was announced recently by Bell Telephone Laboratories. It is a mixture of gaseous helium and neon. This system differs in appearance and mechanical details, but in the principles of inverted population and optical feedback is the same as described for ruby.

The gas maser is a meter-long glass tube, filled with a mixture of helium and neon in the ratio of 10 to 1. It looks superficially like an ordinary neon tube. The ends of the tube are partially transmitting plane parallel mirrors. These windows are aligned parallel to each other by an external optical system. External power to excite the atoms is supplied by a 28-mc generator delivering 50 watts. Most of this rf energy is coupled to the helium. Through collisions, energy is transferred from the helium to the neon atoms. This produces an inversion of the population between excited states in the neon atoms. The energy levels between which inversion occurs are not single pairs as in ruby and calcium fluoride. In fact, 32 such pairs are known to exist. Up to the present, maser action has been observed between only five of these pairs, producing frequencies of 2.68 × 10^8, 2.6 × 10^8, 2.58 × 10^8, 2.50 × 10^8 and 2.48 × 10^8 megacycles in the near infrared.

The emission from the gas maser has, of course, all the properties of directionality, coherence and sharply defined frequency. Indeed, the frequency band emitted is only about 10 kc wide, which gives a fractional bandwidth of about 10^{-10}. Due to the low density of atoms in a gas, the output power is less for gas than for solid-state masers.

Applications

With the development of these powerful, coherent and monochromatic light sources, many new uses of light will become possible. In the past, no light combined all three of these properties to the same extent and at the same time.

One immediate application would be optical radar. Since the wavelength is so much shorter than that of present radars, the resolution could be much higher. Radar systems operating at 1 cm with antennas several meters in height have a beam width, and hence definition, of about 0.5°. This might be compared with an optical maser ½ cm in width, with a beam width of .05°, which through the addition of a simple optical lens system an inch or so in diameter could easily be reduced to .005°. With such a narrow beam width,

radar systems could easily identify the actual shapes of aircraft.

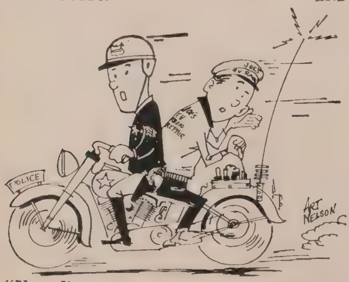
Because of the vast new frequency space that will be opened in the future, the communications industry is vitally concerned with maser developments. At present, communications links operate up to about 10^4 megacycles. The optical maser will extend that range to 10^{14} cycles. This advance is particularly striking when one remembers that all of the frequency span now available to us is contained in 10% of the new region. To appreciate the significance of this, it is only necessary to realize that a color TV channel requires a bandwidth of nearly 10 megacycles. If the existing channels were used in a 10% modulation system, about 100 channels would be available. This is certainly adequate for TV but there is no space left for data transmission or telephony. On the other hand, an optical maser at 10^8 mc with a 10% bandwidth could handle 10^6 TV channels and still have a bandwidth of 10^7 mc left for other uses.

The directional property of optical masers will be useful in earth-to-satellite, satellite-to-satellite and earth-to-moon links. For example, if the output of an optical maser were sent through a simple lens system 4 inches in diameter, the radiation would cover only 2 miles at the surface of the moon. This indicates the possibilities of private communications.

In addition to these applications, the optical maser might be used as a tool to effect chemical reactions. Maser emission is coherent; it can therefore be focused into an area of dimensions comparable to wavelengths of light. Under these conditions all the maser energy could be concentrated within single living cells and selective destruction of tissue (surgery) be performed.

The optical maser can extend greatly the range over which interferometric measurements can be made. Present optical interference measurements are limited to about 100 cm due to inherent line width and low power of monochromatic sources, but significant increases in length are now possible.

We have mentioned a few new applications and scientific uses of light made possible by the optical maser. Most of the new uses will probably be in directions that are not yet apparent. However, we have indicated regions where it is thought uses will be found in the near future. END



"Now listen to it start squealing when we get over 70."

TV Service CLINIC

conducted by

JACK DARR, SERVICE EDITOR

This is *your* column in the magazine: the service is absolutely free; there is no charge for answering your questions, and your name and address will be kept confidential if you so wish. The main purpose of this is to help everyone working in electronics with their unusual problems; so send in your questions; each one gets an immediate personal answer. Later, the more interesting cases are published in the Clinic columns.

Due to the many peculiarities found in commercial TV circuits, you might find a different answer to a question than the one we give, even though the "conductor" of this column is himself a full-time professional TV technician. We would be interested to hear of such cases, as we feel that the more widespread the knowledge of such peculiarities, the better off we'll all be! So, if you have an unusual service job, or one which is giving you trouble from an obscure cause, send in a question on it; we'll answer it promptly and to the best of our ability. (Incidentally, you'd be surprised to know how many times we get a question concerning something on a given set, and then run into the identical condition in the next day or two! In this way, we get an actual check on the validity of our diagnosis.)

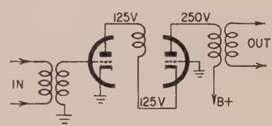


Fig. 1—The basic cascode circuit.

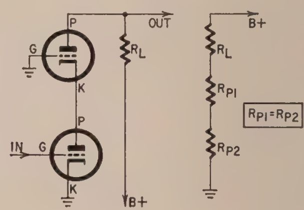


Fig. 2—In most cascode circuits, plate resistances (R_{P1} and R_{P2}) are in series across the power supply.

QUITE some time ago, the cascode circuit was introduced. It looked nothing like the circuits seen up to that time, which was during WW II. Since its invention, it has become about the most popular single circuit in TV tuners (Fig. 1) and has found other applications. Actually, its basic circuit is pretty simple, as shown in Fig. 2. Still, a few TV technicians fail to recognize its basic simplicity, so let's run over some of its characteristics in actual TV tuner circuitry.

What is a cascode? It's a circuit using two tubes, in which the signal is fed directly from the plate of the first to the cathode of the next. What do we do with the grid of that last stage? Ground it! Basically we have a series circuit. We apply B-plus to the plate of the top tube through load R_L, which may be the primary of an rf transformer as in Fig. 1. Current flows through this tube, then on down through the input (bottom) tube, and so to ground. In effect, we have put the plate resistances of the two tubes in series. So, if we're measuring dc voltages across this combination, what sort of division can we expect? If the two tubes are exactly the same, we ought to get exactly the same voltage drop across each one. In other words, each tube should have the same plate voltage, measured to its own cathode. If they become *unequal*, the circuit is upset and we've got troubles, usually appearing as snow.

Let's look at the signal circuits. The basic reason for using cascodes is their very superior noise figure. This, rather than absolute gain, is the most important parameter of any TV tuner circuit. So we use cascodes when we want maximum gain and minimum noise or snow. The circuit functions like this: The first "half" is a triode amplifier. Tube types specially developed for this

circuit, such as the 6BQ7, 6BZ7 and ECC189, are built with very close electrode spacing, giving them a very high mutual conductance (as much as 6,800 micromhos in some versions). We must set up the circuit to get the most usable gain out of it while retaining good stability. So we use a cascode. Since its second stage is a grounded-grid amplifier, we get an extremely stable circuit.

Now let's take some typical troubles encountered in the field. Tube defects in these circuits can cause some very peculiar troubles; some which might seem illogical at first, but which can be explained by a little thinking!

For example, you find three TV sets in a row. One will not pick up any high-channel stations, although the low-channel stations come in fairly well. The next one refuses to pick up low-channel stations, but gets the highs pretty well. And the last one gets both high- and low-channel stations, but is exceedingly snowy on all of them. The experienced TV technician would yank the rf (cascode) amplifier tube out and replace it on *all three*, first! This happens repeatedly in actual field work!

To be quite truthful, I haven't been able to come up with a valid explanation on the first two, although the last one is simple—the tube's just weak! But the solution is same for all three, replace the rf amplifier tube.

Heater–cathode shorts in the output section of the tube cause a lot of trouble, too. Because of the high voltage on the cathode, a short to the heater can burn out the filter resistor in the B-plus line feeding the stage. This is usually a ¼- or ½-watt 1,000- or 820-ohm resistor. When it goes, either the rf stage gets no B-plus at all or much less than normal—so down goes the gain and up comes the snow. So, when replacing a defective cascode tube, it is a good idea to measure the value of the plate filter resistor. This can be done easily in many sets. Take a reading from pin 1 of the 6BQ7 back to B-plus on the turner terminal board. If it is more than 1,000 ohms, look out!

No raster

A Westinghouse H14T171 came into the shop with no raster and insufficient high voltage. After changing all horizontal and high-voltage tubes and the selenium rectifier, to bring up the B-plus voltage, I now have insufficient width and about 6-kv high voltage. B-boost is about 300 volts.

I have changed the flyback, yoke, boost capacitor, coupling capacitor, afc network and other related parts. Resistance measurements are close to normal. Drive on the 12DQ6 is 64 volts peak to peak with about −16 volts bias. There is 98 volts at the plate of the first section of the horizontal multivibrator and −11 volts on its grid. If I connect a 400-volt boost from another set, high voltage rises to about 8 kv.—I. M., Holly Springs, N. C.

The key clue here is the drive voltage at the grid of the 12DQ6. It should be 90 volts peak to peak (Fig. 3), which should develop −20 volts dc bias! The

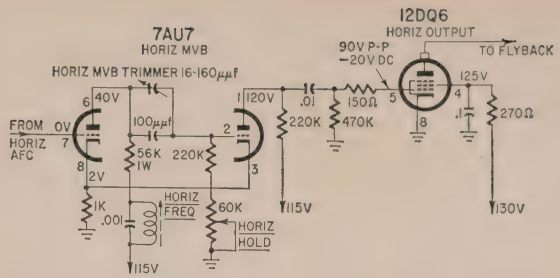


Fig. 3—Horizontal sweep circuit of Westinghouse H14T171.

lower voltage would cause the drop in high-voltage, boost, and all of the other symptoms.

Check the horizontal oscillator stage very carefully, especially the plate voltages and the tube itself. If it has been replaced, replace it again! Check the resistors in the waveshaping networks in the horizontal oscillator; they are fairly critical.

Another obscure defect which often causes such troubles in series-string filament sets is the heater voltages on critical tubes—damper, horizontal output and oscillator. Measure these voltages directly on the heater pins of the tubes, not at the socket lugs! We found one set which had only 7 volts on a 12-volt damper!

Finally, check the 115-volt line which feeds the 7AU7 plate through a 220,-000-ohm resistor. Trouble here might be caused by video if tubes, bad audio tube, etc., upsetting the 115-volt line.

No brightness

There is no brightness on the screen of an Admiral 21D1 although the sound is OK. The 47-ohm resistor in the cathode of the 6BQ6 keeps burning up (Fig. 4). The grid reads −7 volts. The horizontal oscillator doesn't seem to be working right.—V. A., So. Ozone Park, N. Y.

The horizontal oscillator either isn't working at all or isn't working right. Grid voltage on the 6BQ6 should be at least 25 volts negative and closer to 34. The resistor is burning up because the 6BQ6 is not being driven hard enough to hold the plate current down.

Run a complete setup procedure on the horizontal oscillator, after substituting new tubes in both stages. Check all resistors and capacitors in the oscillator stage and replace the horizontal oscillator transformer if nothing else shows up.

Poor vertical linearity

I have a Tele-Tone TV-208 which has been butchered pretty badly. After a lot of work, I've got a picture and sound, but vertical linearity is bad. If I turn the vertical size control beyond a quarter-turn, the whole pix collapses. Also, there are bad retrace lines on the raster.—L. F. C., Haskell, N. J.

The collapse of the vertical sweep when the size control is turned may indicate a bad control or incorrect bias

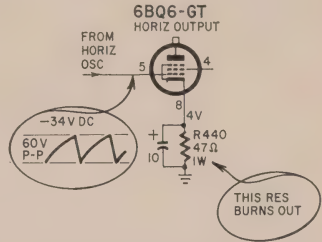


Fig. 4—Cathode resistor keeps burning out because of insufficient grid drive.

caused by leaky capacitors or bad resistors. Since the set has been butchered, check the whole stage carefully for wrong-value resistors and capacitors. Incorrect bias can make the stage stop oscillating when the size control is turned.

Color conversion

I have a 5TP4 projection tube with all high-voltage supplies, etc. I want to build a color TV projector using the Colordaptor system. Can you tell me what TV chassis to use?—K. M., Willow Grove, Pa.

Your best bet would be one of the older hot-rocks with four stages of video if, etc.—the Stewart-Warner 9126 and similar sets. These can be tuned to the required 5-mc bandwidth, essential for good color reception, and have plenty of gain. Some of the older custom-builts, like Fleetwood, Tech-Master, etc., should also work.

Whiteout

In a Philco 7L70, the picture comes on fairly good. Within a few minutes, it begins to grow whiter and whiter, until there is a bad loss of detail in the highlights and an apparent loss of focus. I suspected the picture tube, but it seems to be all right, at least on our checker. All the voltages on the picture tube check OK. What is causing this "whiteout"—M. I. S., New Braunfels, Tex.

This is due to a defective 12BV7 video amplifier tube. The exact nature of the defect is rather obscure as the tube will check fairly good in a tube tester. It is probably due to some occluded gas in the tube which causes it

(*Continued on page* 64)

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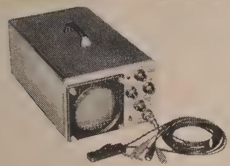

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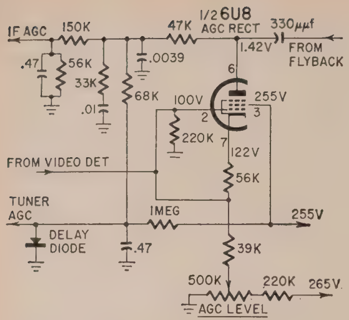


Fig. 5—Agc circuit of RCA 21T6082.

(*Continued from page* 61)

to become gassy after full heating up. Gas currents in the grid will cause the plate current to be erratic, thus limiting the gain of the tube—and reducing the amplitude of the video signal. Since the amplitude of the video signal determines the blackness of any portion of the picture, you get a whiteout.

Agc at fault?

I'm having trouble with an RCA 21T6082. I'm sure it's in the agc since I can ground out the agc and get a good picture. When I first turn it on, there is 54 volts on the agc tube. Ac feedback voltage from the flyback is 300.—E. E. H., W. Haven, Conn.

This *is* agc trouble. Your key reading is that positive voltage on the plate of the agc rectifier.

The trouble lies in that agc plate. It should never go positive by that amount. This is probably due to trouble somewhere in the voltage-divider resistors which feed that circuit (Fig. 5 shows proper values and voltages). Any incorrect resistances in here would upset the critical voltage distribution around this section of the tube but good. That signal voltages are obviously getting to the grid as they should is shown by the voltage variations you noted.

Poor noise immunity

One of our customers has a 1955 Fleetwood, with very good picture quality, etc., but pretty poor noise immunity, especially to automobile ignition noise. We believe that the circuit could be changed to help this. Our idea was to hold one stage of video amplification constant and move the contrast control to the cathode of the last video amplifier. The sync takeoff would be ahead of this point.—M. & G., Cobden, Ontario.

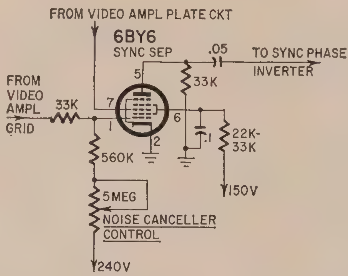


Fig. 6 — Modification of Fleetwood noise-cancelling circuit. Values are determined by experimenting.

Unless I'm misreading the schematic, this chassis now seems to have practically no provision for noise cancellation, although it does use the 6BY6 tube widely used for this purpose in many later models. Therefore, I believe I'd leave the video amplifier stages alone and rework that 6BY6 stage to make it the same as the circuit used in the newer sets (Fig. 6).

This should give you better noise immunity. The present contrast control in this set is actually an agc control, similar to the circuit used in the old G-E 800 series. It regulates the gain of the video if amplifiers. Therefore, it should be set carefully for best results. Check all of your video if tubes for gas. Check the horizontal afc circuit very carefully, replacing all resistors that show more than 5% deviation from rated values and all capacitors that show any signs of leakage.

One further suggestion. You might solve the whole problem by increasing the signal level! Use a higher-gain antenna with an antenna booster that will give about 25 db gain. The use of coaxial-cable (72-ohm) lead-in will eliminate quite a bit of ignition noise pickup, but you'll have to "replace" the signal lost. The best way is with an antenna booster.

Vertical rolling

In a Motorola 10VT10R, the picture starts to roll after 15 minutes and the vertical hold control has no effect. What is probable cause?—F. B., San Diego, Calif.

From the 15-minute time constant of this trouble, it would seem to be thermal. The trouble doesn't show up until the set has had time to get warmed up. This would point to a resistor—troubles due to capacitors or tubes show up more quickly.

Check the resistors in the plate and grid circuits of the 6J5 vertical oscillator. Hold the tip of a soldering iron on each one with an ohmmeter connected across it. You'll probably find one of them change drastically as it heats up.

If this doesn't cure the trouble, check the coupling and time-constant capacitors, using a capacitor checker which reads leakage. Slight leakage in a coupling capacitor can give you the same effect, although drifting resistors are the more common cause.

Visible drive line

The subject is a Silvertone 528.631-1. I'm having difficulty getting rid of the vertical white line usually associated with misadjustment of the horizontal drive control. Turning the control one way makes the line very bright. Turning the other way makes the line break up into three lines at the right side. At this point the picture gets darker and

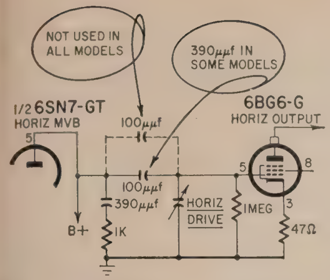


Fig. 7—Drive line may be caused by leakage in horizontal drive trimmer.

is beyond tolerance.—D. R., Newcastle, Pa.

This is undoubtedly a drive line. The horizontal drive in this chassis is the shunt type—a small trimmer capacitor connected from the 6BG6 grid to chassis (Fig. 7). I note that they use an extra capacitor in shunt across the coupling capacitor, as shown. Disconnect both of these and check for leakage. Quite often the trimmer capacitors used here develop leakage from moisture. Take it completely apart and replace the mica.

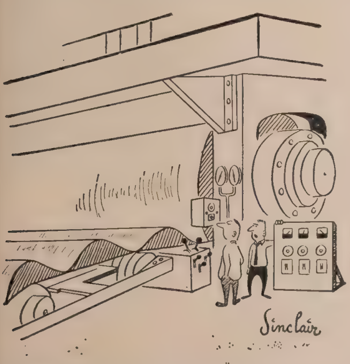
Check the waveform at the 6BG6 grid. It should be a good, smooth sawtooth, at 45 volts peak to peak. If it is incorrectly shaped, with ringing, etc., go back into the oscillator circuit and check all the waveshaping R-C networks.

Lower the if?

I would like to change the sound if in a TV turret tuner to 10.7 mc, and run it through a regular FM if strip and detector.—J. C., Davis, Calif.

I'm afraid not! The sound and picture frequencies in a tuner are heterodyned with the local oscillator and come out as the video and sound if's. Actually, the 4.5-mc sound if never appears in the tuner at all, but shows up first in the video detector! It is a product of a beat between sound and picture carriers in the nonlinear detector.

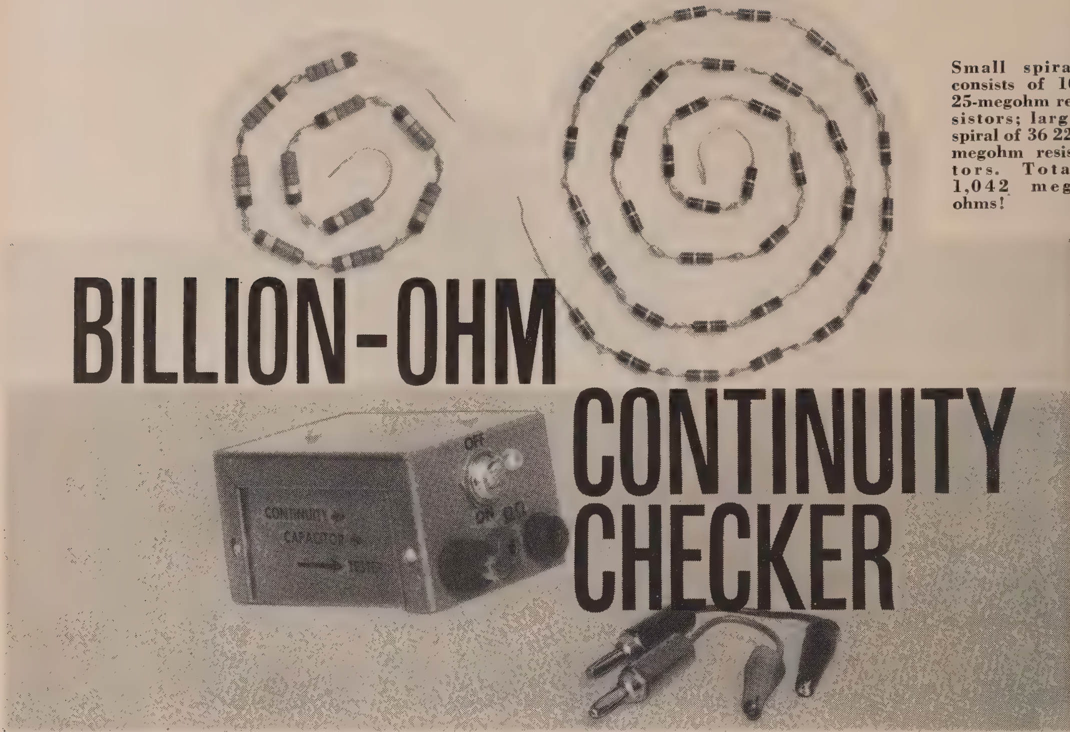
To do what you suggest would require adding another oscillator in the tuner! I don't think you'd gain much by trying this, and it would be a difficult job! END



"I think you're picking up 60-cycle hum on the thickness control."

Atomic-Age version of the old flashlight continuity checker also doubles as leakage indicator, capacitor checker and signal injector

BILLION-OHM CONTINUITY CHECKER



Small spiral consists of 10 25-megohm resistors; large spiral of 36 22-megohm resistors. Total 1,042 megohms!

By JACK LIPINER

IN actual tests with this completed miniature continuity tester, the neon indicator still glowed brightly with a resistance of 1,050 megohms in the circuit, and looked as if it might go much further! Such a demonstration of resistance-range capacity places this small, battery-powered tester in the sensitivity range of vtvm's. It far surpasses the limits of sensitive multitesters, whose high ohms range seldom goes above 100 megohms.

Fig. 1 is a simple circuit for low-resistance continuity and short checking. However, when resistance between the test prods reduces battery voltage to the point where the incandescent lamp cannot light, the device ceases to operate. Fig. 2 is a table of approximate R_x resistance limits for battery voltages from 3 to 12 for various lamps. With higher values of R_x the lamps won't light. As you can see, the R_x limit increases directly with the applied voltage. A simple 3-volt flashlight continuity and short checker is very useful around the shop, but limited to resistances up to 10 ohms.

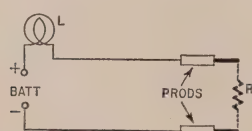


Fig. 1—Simple circuit for checking continuity.

With the ever-present desire to make miniature testing devices, the problem is how to increase the voltage supply in a continuity checker to meet the usual requirements of testing for continuity, leakage, shorts and yet not require bulky batteries which would make the instrument larger.

In the November 1954 issue of RADIO-ELECTRONICS, page 125, is a schematic (Fig. 3) of a small continuity checker which meets the requirements of a larger voltage supply. This schematic is based on an article by G. A. French in the *Radio Constructor* (London, England), in which the tester operates from a 6–9-volt dry battery. Higher voltage to send the current through high resistances is delivered by a vibrator type supply which uses a 6-volt buzzer.

The article in RADIO-ELECTRONICS states: *"When the switch is turned on, the buzzer functions, resulting in the rapid collapse of the magnetic field, which, in turn, induces in the coil a voltage many times higher than the initial battery voltage. This higher voltage is rectified, filtered and then applied to the neon indicator. The brightness of the glow in the neon is determined by the resistance between the test prods."*

There is no description of an actual tester. However, there is a final statement: "A miniature battery and buzzer will enable you to tuck this instrument into a pocket-size cigarette case." The resistance limit in the article is estimated: ". . . . *checks leakage and continuity up to about 10 megohms."*

This estimate was extremely modest! Following the 1954 circuit, with modifi-

Battery Volts	Lamp L	Limit—Rx Resistance Ohms
3	No. 222	10
6	No. 425	20
9	No. 993	115
12	No. 993	150

Fig. 2—Approximate resistance limits for continuity checkers using the Fig. 1 circuit.

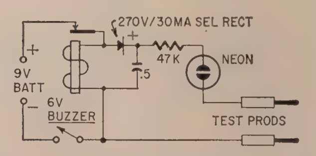
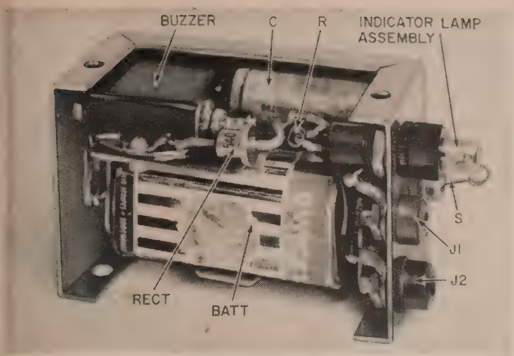
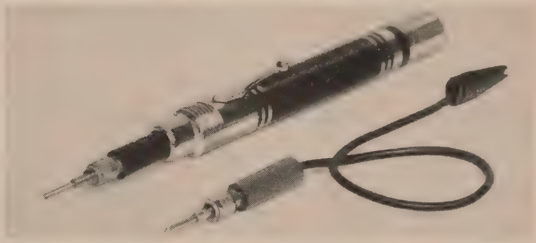


Fig. 3—Circuit of 10-megohm continuity checker which appeared in *Radio-Electronics*, November, 1954.



Inside the checker space is at a premium.

A simple continuity checker of the type shown in Fig. 1. Lamp is in end of probe.



cations where necessary, I built the instrument shown in the photos and Fig. 4. Powered by a 6-volt battery, the device indicates circuit continuity even with a series resistance in excess of 1,000,000,000 ohms! This is 100 times greater than the 1954 estimate! On the opposite end of the scale, the simple continuity checker of Fig. 1 (this time with a 6-volt battery) will not register continuity of resistances over 20 ohms. By adding a buzzer, capacitor and rectifier, the checker (Fig. 4) becomes 50,000,000 times more sensitive.

Construction

The smallest case that will house the components satisfactorily measures 3¼ x 2⅛ x 1⅝ inches. The photos show the suggested parts layout.

The vibrator power supply is built around a 6-volt buzzer (Edwards No. 15). It has only two screw connections, so point X in Fig. 4 is the buzzer case. Fasten a solder lug to the case and connect the negative side of the silicon rectifier to it.

The battery is held in place by a battery holder which is fastened to the case with two No. 4/40 nylon screws attached to a 1½-inch square of insulating bakelite strip. This strip is fastened with two No. 2/56 nylon screws to one bracket of the battery holder. As stated above, the top buzzer supporting screw also holds the solder lug for one side of the rectifier. To avoid contact with the outside metal case, tape the front cover of the buzzer, also the top, inside, bottom and sides of the outside case at all possible contact points with strips of electrical tape.

The Dialight Corp. neon indicator employs the NE-2H lamp which gives a brighter glow than the ordinary NE-2. The Dialight No. 7538 holder with a replaceable No. 38H-1533 lamp cartridge is very efficient, occupies minimum space, and enhances the appearance of the checker.

The on–off switch is the standard miniature spst toggle switch with two wire leads already attached. This switch is available at most electrical supply retailers. You can pick up the buzzer at the same time.

Most 0.5-μf 400-volt capacitors are rather long and bulky. However, a suitable capacitor is the Solar Solite metallized-paper unit which measures about 19/32 x 1⅝ inches. Other metallized units of equivalent size can also be used.

Operation

When the switch is turned on, the buzzer starts. To determine if the neon indicator is functioning, short the test prods. If the neon does not glow, reverse the battery for proper polarity. After obtaining a neon indication with direct shorting, check continuity of resistances between the prods by observing the neon for glow.

The versatility of this tester is demonstrated by its ability to check several features of vacuum tubes. The usual lower-priced tube tester will check direct shorts and interelectrode leakage up to about 250,000 ohms. Since many circuit aberrations are traced to leakages exceeding this resistance limit, the usual tube checker is unable to detect them. Mutual conductance (g_m) testers costing about $200 or more usually feature interelectrode leakage tests up to about 20 megohms. The billion-ohm continuity checker provides tests for filaments, shorts and all high-resistance interelectrode leakages. Thus, it becomes a valuable accessory to any tube checker.

While this device is not primarily a signal injector, it can be used for this purpose. When coupled through a suitable capacitor to a broadcast receiver, signal injection was effective at the usual application points along the entire path. Sometimes only one prod was sufficient but for stronger response both prods were employed.

Mica and paper capacitors can be tested for opens, shorts and leakage by the glows and flashes of the neon indicator. To obtain standards for capacitor tests, establish the response of a good capacitor and compare this standard with results obtained in future tests. A direct short or bad leakage will approach a steady flash or bright glow. Fainter flashes or glows at varying rates indicate gradations of quality of the capacitor.

The neon will continue to glow after a high-resistance continuity test (the resistance still attached to the prods), even after the switch is thrown to the off position. This is caused by the charge remaining in the unit's filter capacitor. Short the prods (you'll get a bright flash in the neon) to discharge the capacitor.

Even though a 6-volt battery is the basic power supply, the buzzer produces enough voltage to cause a rather stinging shock if the unwary operator touches both bare prods at the same time while using the tester.

The increased range of this tester over that of the unit in Fig. 3 can be attributed, possibly, to the use of the NE-2H or the silicon rectifier or both.

Standard 6-volt transistor batteries will not make an efficient power supply for this tester since the buzzer draws a higher current drain than these batteries can deliver, even for a short period of time. The Z4 battery was chosen as more efficient. However, it is never advisable to keep the buzzer operating for long periods, since current drain is high. This battery will function satisfactorily for the short periods required for ordinary testing.

Because of the type of current produced in this checker, low resistances can be tested without damage to them. Continuity tests were made on No. 222 penlight lamps, on 6- and 12-volt tubes, without injuring their filaments.

If, in the future, a smaller buzzer is produced which draws less current and requires a smaller-sized battery, it is likely that this instrument can be housed in a case the size of a penlight flashlight. END

BATT—6 volts (Burgess Z4 or equivalent)
C—0.5 μf, 400 volts, metallized paper
J1, J2—insulated banana jacks
R—18,000 ohms, ½ watt
RECT—400 PIV, 500 ma, silicon (General Instruments Corp. PT-540-J9)
S—spst toggle switch, with wire leads (Cutler-Hammer 8391-K7 or equivalent)
Buzzer, 6 volts (Edwards Co. No. 15 or equivalent), obtain from electrical supply house
Neon-lamp assembly (Dialight No. 7538-38H-1533 or equivalent)
Nylon machine screws, 2/56 with nuts (4)
Nylon machine screws, 4/40 with nuts (2)
Case, 3¼ x 2⅛ x 1⅝ inches
Miscellaneous hardware, etc.

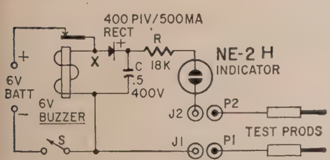


Fig. 4—Circuit of 1,000-megohm continuity tester.

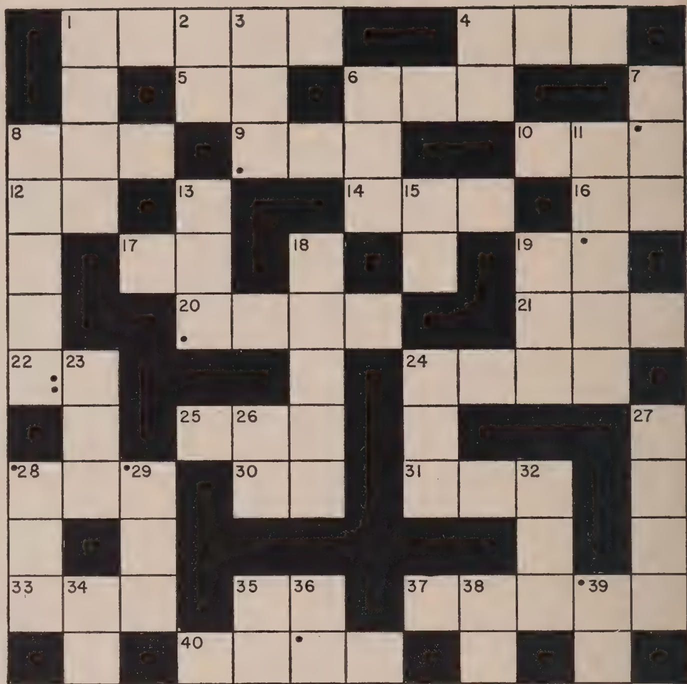
ELECTRONIC NUMBERS PUZZLE

By JOHN A. COMSTOCK

LIKE to work with numbers? Here is a puzzle that is built around some of the numbers often used in radio and television. Many of them are already familiar to you. Others you will have to work out, using pure logic and, in some cases, simple math and an electronics formula.

If you find crossword puzzles entertaining, you'll enjoy every minute of this puzzle. It's something new—fun to do—educational, too!

(Answers on page 110)



ACROSS

1. In monochrome TV, the horizontal scanning frequency.
4. The frequency (in kc) received by a superheterodyne receiver with a 456-kc if and the local oscillator operating at 1056 kc.
5. The voltage drop across a resistance of 65 ohms when current flow through the resistance is 1 ampere.
6. A common 3-phase power voltage.
8. The wavelength in meters of a 3-mc signal.
9. The decimal by which milliamperes must be multiplied to convert to amperes.
10. The total number of lines in one frame of monochrome television.
12. The lower limit of TV channel 2 in megacycles.
14. A common intermediate frequency often used in AM superheterodyne receivers.
16. In rpm, a fast record-player speed.
17. One of the slower record-player speeds in rpm.
19. The vhf TV channel that extends from 204 to 210 mc.
20. 500 micromicrofarads converted to microfarads.
21. 950,000 watts expressed in kilowatts.
22. TV aspect ratio.
24. The year Marconi invented the first wireless telegraph.
25. The approximate number of degrees plate current flows in a class-B amplifier.
28. The frequency in kilocycles of a 429-meter signal.
30. The value of a resistance when voltage drop is 160 volts; current flow, 2 amperes.
31. The upper limit in megacycles of the vhf spectrum band.
33. The second harmonic of 376 kilocycles.
35. The power dissipated in a resistance when voltage drop equals 46 volts; current flow 1 ampere.
37. The value of a resistor color-coded brown, green and orange.
40. The year official television broadcasts began in New York.

DOWN

1. The year Fleming invented the diode vacuum-tube detector.
2. The lower limit in megacycles of TV channel 5.
3. In kilocycles, the original lower limit of the commercial AM broadcast band.
4. The field-frequency rate of television.
6. The voltage drop across an ac circuit when impedance is 107 ohms; current flow, 2 amperes.
7. In color TV, the color burst frequency in megacycles.
8. The horizontal scanning frequency used in color television.
11. The frequency in the Citizens band assigned exclusively to the radio control of model planes, garage-door openers, etc.
13. The watt-hour power consumption of a 75-watt portable TV operated for a total of 2 hours.
15. The heater voltage of a vacuum tube such as the 50L6, 50C5, etc.
18. The output in meters of a transmitter operating at 30 kilocycles.
19. The peak voltage output of a power supply which has an effective voltage output of 141.
23. The common impedance in ohms of TV ribbon type twin-lead.
24. A common high-voltage half-wave rectifier often found in TV sets.
26. The lower limit of the FM broadcast band expressed in megacycles.
27. The capacitive reactance of a 0.5-μf capacitor at a frequency of 60 cycles.
28. The factor by which the peak value of an alternating current or voltage must be multiplied to find the effective value.
29. 12 milliamperes of current expressed in amperes.
32. The number of zeros represented by the letter K used in resistor values.
34. The mid-frequency of TV channel 2.
35. The total resistance in ohms of two resistors (one 27 ohms, the other, 22 ohms) connected in series.
36. The heater voltage of a 6BQ6.
38. The total capacitance of two 25-μf capacitors connected in parallel.
39. .00004 ampere expressed in milliamperes.

END

Some service hints that help take these tricky circuits out of your hair

Servicing stacked-B circuits

By **JACK DARR**
RADIO-ELECTRONICS SERVICE EDITOR

STACKED-B circuits are up near the top of the service technician's headache list. Properly designed, a stacked-B supply is a good circuit and works as well as any other kind.

The basic arrangement is simple. Most sets already have a positive 250—375 volts on hand for high-voltage and sweep circuits. We just apply this excessively high voltage across a combination of two lower-voltage circuits. By connecting them in series—plate of one to cathode of the other—we can use the high B-plus without heavy divider resistors.

We use one high-current power amplifier, usually in the audio output stage, in the "top" half of the circuit, and tie a group of other tubes, usually all voltage amplifiers (low-plate-current types) "below" it (Fig. 1).

By selecting the proper tube types, we can get whatever current we need for the bottom half of the circuit.

For example, if a 6V6 or 6AQ5 is used in the top half, we can set it up for about 2 watts audio output (ample for home use) and have about 180 volts on plate and screen, with a 30-ma cathode current. With these values, we can tie on any number of tubes until we reach our total of 30 ma cathode current. For example (Fig. 2) if we had six tubes, each requiring 5 ma, we would come out just right.

The designer usually does things the other way around. He selects the tubes he wants in the bottom half of the circuit, then for the upper half chooses a power tube that will give him the proper cathode current. Adjusting operating voltages and power-tube bias gives him the values he needs. For this reason, operating voltages are always critical in this type of circuit, much more so than in conventional ones. Some actual examples will be given in a moment.

If the technician can always remember that this hookup is simply a voltage divider, he won't have any trouble seeing the circuit in his mind. They are exactly the same—vacuum tubes are used in place of fixed resistors, that's all.

Now, with our "voltage divider" properly balanced, we portion out the available supply voltage between the top and bottom halves. While the peak supply voltage shows quite a bit of variation, from 250 to 275, the bottom half seems to be 150 volts, in all of the sets I've checked over. This is a good average value of supply voltage for video if plates and similar applications, and this is probably why it was chosen.

Let me repeat once more, for added emphasis, that this whole circuit is basically a dc voltage divider, with vacuum tubes used in place of fixed resistors. The "resistor" in each half of the circuit is the tube's dc plate resistance.

Commercial circuits

Now let's look at a few examples of how this principle is used in actual circuits. Note how it divides almost equally between the two halves.

This circuit is used in quite a few recent TV sets in first and second video if stages (Fig. 3). Identical tubes are used here, but they need not be. Other types could be used by adjusting plate and screen currents. Notice the operating voltages indicated at the tube elements. The division is almost exactly half in this particular set. By adjusting bias voltages the designer can cause either tube to take any desired share of the voltage. Correct voltages are shown in the service data for each set. If you get trouble in these stages, it will almost always show up as unbalanced dc voltages.

There is one more case (fortunately pretty rare) where initial voltage measurements might mislead you into thinking that you had a stacked-B circuit in the video if. Standard design practice of late seems to be stacking the first two video if's, with the highest plate voltage being applied to the second. In the Bendix 21K3, seen in Fig. 4, the highest plate voltage is applied to the first video if! Checking grid and cathode voltages indicates that this stage must be stacked with another, somewhere! Check the schematic carefully, and we find that the 230 volts on the cathode of the 6BA6 is used as the B-plus supply for the 6BQ7 in the tuner! This, in effect, is a triple stack of tubes, since the 'BQ7 itself is stacked (Fig. 4-b).

Servicing

These circuits can be difficult to serv-

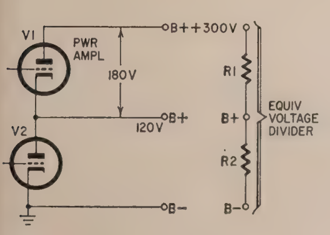


Fig. 1—Basic stacked-B circuit. Tubes act as a voltage divider.

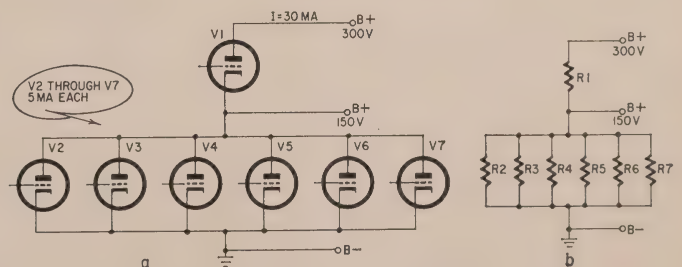


Fig. 2-a—Typical stacked-B circuit. b—Equivalent circuit.

ice because of the interdependence of the tubes for operating voltages. A defect in one stage can cause trouble in another. Fig. 5 is a good example of this. It's a very strong hum bar, and 60-cycle hum bars, as everyone knows, are *always* caused by heater–cathode leakage in the video if or video amplifier tubes. Oh, yeah? This one was caused by a shorted 6AQ5 in the audio output stage of a stacked-B circuit. The cause was heater–cathode leakage. The 60-cycle hum voltage was being directly impressed on the plate supply voltage for the video if and video amplifier tubes.

So, when servicing any modern set, if the symptoms don't seem to agree with your tentative diagnosis, get out the schematic and look for a stacked-B circuit hiding somewhere.

Since the tubes not only control the amount of amplification, but also determine the operating constants of several stages besides their own, their condition becomes very important. So when troubleshooting, test *all* tubes first. This means not only the power tube in the upper half, but all tubes connected to the 150-volt line on the lower half too. Heater–cathode shorts, leakage, gas or interelectrode leakage can really play hob with voltage distribution in such circuits!

After this primary test, check the B-plus supply voltage. If it isn't within 5% of the value called for in the service data, find out why and get it back to normal before going further.

Low voltage

If an unexplainable low-voltage condition is found, break the B-plus circuit, and insert a milliammeter to read the total supply current. While this value is never given in service data (although it ought to be), it can be checked pretty closely. For example, if the set uses 500-ma selenium rectifiers, and you read a total current of 490 ma, something's wrong somewhere. There should be at least 100 ma of reserve capacity for semiconductor rectifiers, and an equivalent amount for tubes.

A few checks on sets as they pass through the shop will enable you to make up a table of average current drain for the various types. You might even take this reading on each set, and note it right on the service data. In a lot of sets, it can be read quite easily; just lift the B-plus fuse and hook up a milliammeter in its place to get a quick reading.

Once tubes and supply voltages test OK, the serious checking can begin! Probably the best way to check a stacked-B stage is to measure plate and cathode voltages over the whole string. Although signal voltages are important, dc operating potentials are even more so. Unless they are correct, we have no chance of getting our signals through the stages with anything like the correct amplification. So check 'em out like a string of diodes. Compare the measured voltages with those shown in the service data. Any discrepancy must be located and corrected. If the initial plate–cathode voltage checks show trouble, measure control- and screen-grid voltages.

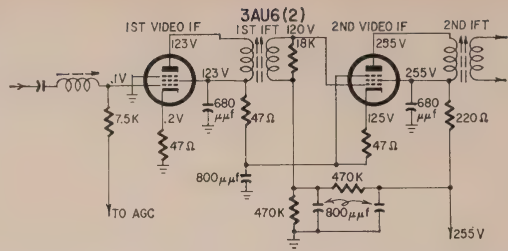
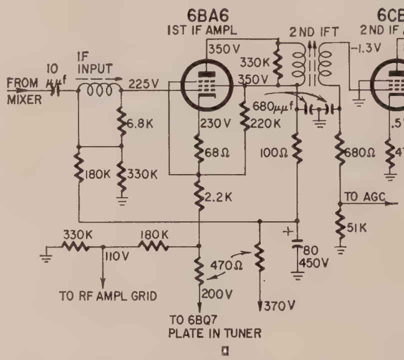


Fig. 3 — Stacked-B arrangement used in the if strip.

Components are very important in such stages, because of the divider action. Look closely at the circuits in the illustrations. You'll see that resistors play an important part in the voltage distribution, feeding operating potentials to grids, cathodes, etc. For example, look at the voltage-divider network in the grid circuit of the 6BA6 in the Bendix of Fig. 4. Although it is in the grid circuit, it returns to the 370-volt supply! As you can plainly see, any shifting of values in this network and you've got trouble.



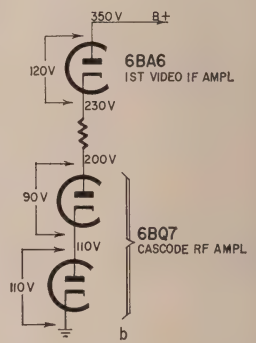


Fig. 4—Unusual stacked-B circuit in the Bendix 21K3. b—Equivalent circuit reveals a three-stage stacking.

Capacitors used in these circuits must have practically no dc leakage at all. Because of the wide range of voltages encountered, only high-grade capacitors are suitable. You may find a capacitor connected between a −50 and a +375-volt source. Obviously, a 200- or 400-volt type isn't going to stay around too long here! While we're used to thinking of coupling capacitors in grid circuits as being the most critical, you'll find that excessive leakage in a capacitor *anywhere* in this circuit can cause trouble! So if an inexplicable unbalance is found in any stacked circuit, start checking capacitors.

Fig. 6 illustrates two points: first, the number of stages you may find hanging on the bottom half of a stacked-B circuit, and, second, the importance of proper filtering and bypassing of that lower half. Notice the 6W6 cathode circuit (the 150-volt source). Right on the cathode is a whopping 100-μf electrolytic which, just for luck, is bypassed with a 680-μμf ceramic. Following the 150-ohm filter resistor, there is the output capacitor, the 40-μf unit shunted by a 15,000-ohm resistor, to help stabilize the 150-volt line. This filter is the familiar π-section used in all power supplies. It must remove, not only all 60-cycle ripple still present, but also all audio, video, sync, vertical and horizontal pulses which might be floating around!

Therefore, if some sort of unusual trouble shows up, grab the scope and

Fig. 5—Severe 60-cycle hum cause by heater–cathode leakage. Guess where?

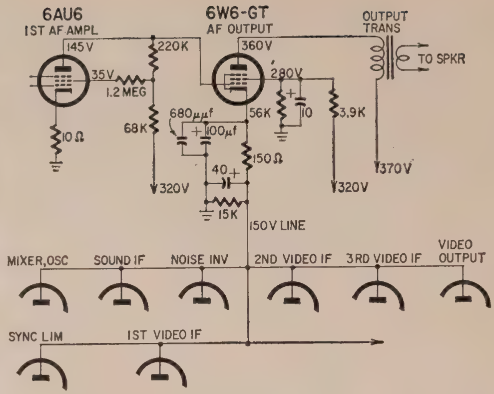


Fig. 6—Eight tubes on the lower half of this stacked-B circuit.

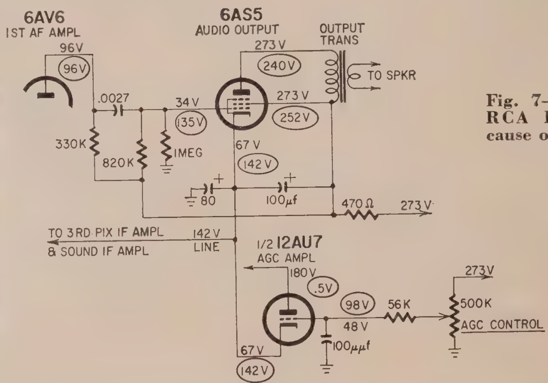


Fig. 7—Partial circuit of RCA KCS-92 showing cause of agc trouble.

check this 150-volt line for signs of excessive ripple at all possible frequencies.

Interaction of stages

Finally, watch out for troubles which may appear to be in one stage but actually are somewhere else! Such electronic mirages are quite common in the typical stacked-B circuit.

A good example of this was an RCA KCS-92 chassis which came in with a very obvious case of agc trouble. All the standard symptoms were there: complete whiteout of the screen, excessive agc voltage and so on. There was only one wee problem—the agc circuit was OK! Fig. 7 shows the parts of the circuit actually involved in the trouble. The voltages at the tube elements are those actually measured during the trouble—the circled ones are the right voltages. Now, before you go any further, can you spot the trouble?

The key clues here are the control-grid and plate and screen voltages on the 6AS5 audio output tube. Notice that plate and screen voltages are high and the grid is way off, only 67 instead of the normal 135 volts. The cathode is off, too, 67 instead of 142 volts. The suspect here, and I checked first, was the coupling capacitor between the 6AV6 plate and the 6AS5 grid. I could have saved myself the trouble by reading the 6AV6 plate voltage more closely; it was still normal. The 1-megohm resistor to ground was also good. This left only one more and, sure enough, there it was. The 820,000-ohm resistor between the 6AS5 grid and the 273-volt line was "slightly" off—it measured something like 13 megohms! The loss of this bucking voltage, used to adjust the bias on the 6AS5, allowed the grid to go highly negative. The actual control grid voltage was −34 volts. This caused the tube to cut off. So, we were dropping 206 volts across the plate resistance of the 6AS5, instead of the 131 volts we should have had. This upset the 142-volt line, which changed the bias applied to grid and cathode of the agc tube and caused it to go phooie. A very high agc bias was applied to all controlled stages, and we got the whiteout.

So no matter what kind of symptoms you find in one of these sets, take a very close look at the schematic, and especially the dc voltage data. See if there isn't a stacked-B circuit in there somewhere. If there is, it may be causing your troubles in some such obscure way! Always be alert for such interlocking actions, and you'll not only save a lot of time, but lots of money previously blown on aspirin! END

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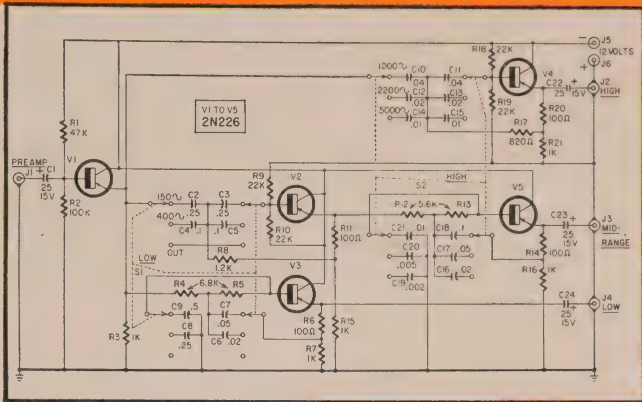

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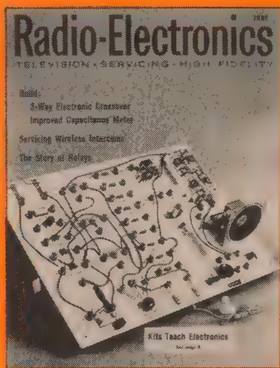

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By I. QUEEN
EDITORIAL ASSOCIATE

CRYSTAL BEATNIK OSCILLATOR

An unusual signal generator or calibrator that uses three crystal-controlled transistor oscillators to develop spot frequencies ranging from a few kc to well above 50 mc.

A CRYSTAL oscillator is the simplest and most accurate device for generating precise rf signals. A few inexpensive parts—a crystal, a transistor and a battery—make a complete and useful oscillator (see page 82, January 1960). However, the crystal oscillator has one disadvantage. It is limited to a single fundamental frequency. You need as many crystals as fundamentals.

The number of frequencies per crystal can be increased if you use a pair of oscillators coupled by a diode mixer. The two oscillators then generate beats that extend over a wide spectrum. The beats are especially useful when the crystals are ground for convenient frequencies such as 5000, and 7500 kc, and when the frequency difference between them is a convenient 100 or 500 cycles. However, any pair of crystals between about 3 to 9 mc seems to work in this "beatnik." Of course, *all* the beats are *crystal-controlled.*

Here is an example. Assume that 7000- and 7050-kc crystals are used. Beats will occur at 50-kc intervals that originate at the fundamentals. An all-wave receiver will tune in signals at 7100, 7150 and 7200 kc and so on, as well as both fundamentals. Similarly, there will be beats at 6950, 6900, 6850 kc, etc. The beats are strongest near the fundamental frequencies. These show up well on the S-meter of a receiver. Weaker ones can be detected with the aid of a local bfo.

Harmonics are always present so there will be crystal-controlled output at 14,000 and 14,100 kc also, when using the above crystal pair. Thanks to the beatnik, however, many more crystal-controlled markers are available. As before, beats appear at 50-kc intervals above 14,100 kc and below 14,000 kc, as well as at 14,050.

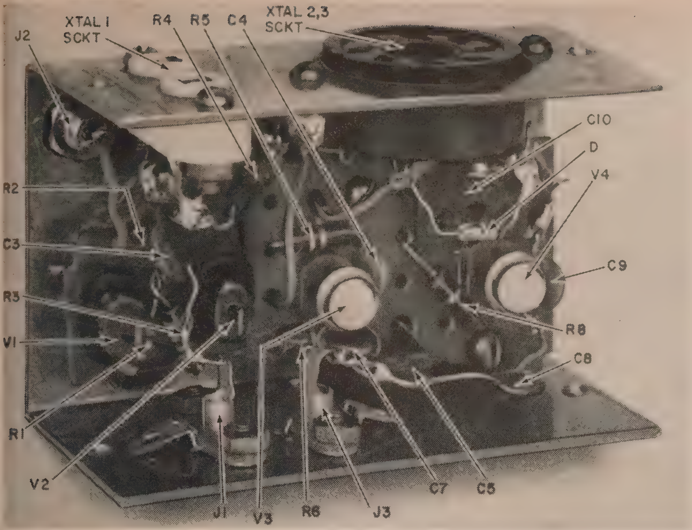
When the interval between beat frequencies is small compared with the fundamentals, the amplitude of the beats decays and dead spots may appear between successive harmonic groups. Fig. 1 shows a typical spectrum (not drawn to scale). A and B are the crystal fundamentals; each accompanied by a train of beats which decay in amplitude. The harmonics, 2A and 2B, are also centers of beat clusters. If there is a wide interval between any two beat frequencies, the beats remain strong until reinforced by the various harmonics.

If the crystal pair consists of 7000- and 7500-kc crystals, for example, the interval (500 kc) is relatively large. The result is continuous coverage of the entire spectrum with 500-kc markers. With 5000- and 5500-kc crystals, the coverage is still better. The amplitude of the beats remains constant and strong beyond 50 mc and down to the broadcast band!

A combination of 5000- and 7500-kc crystals results in beats at every multiple of 2.5 mc as expected. Strangely enough, each is *tone-modulated.* This may be explained as follows. No crystal is exactly on frequency, so the 7.5-mc crystal may actually be 7.501 mc. When this beats with the 5-mc crystal, we get a 2.501-mc signal. However, when the 7.501-mc crystal beats with the 10-mc second harmonic of the 5-mc crystal, we get 2.499-mc signal. The 2,000-cycle difference between 2.501 mc and 2.499 mc provides the audio signal. The exact frequency of the tone depends upon the *actual* crystal frequencies, not their marked values.

With a 5000-kc and 7000-kc crystal combination one might expect only odd integral megacycles. Actually, there is an output at every integral megacycle, giving the equivalent of a 1-mc oscillator, except that the beatnik output seems much greater, even at 55 mc.

The beatnik may be used with crystals differing only slightly in frequency too. For example, 3575- and 3550-kc crystals permit calibrating a portion of the 80-meter band at intervals of



A look at the beatnik's innards.

Fig. 1—Typical spectrum of crystal markers obtained with the crystal beatnik oscillator.

only 25 kc. Such a pair would also calibrate higher harmonic bands.

You can also pair up crystals that are nearly in the ratio of some small number. For example, 4300 and 7600 are nearly in the ratio of 2 to 1. The second harmonic of 4300 is 8600, which is exactly 1 mc from the other crystal, so we get markers at 1-mc intervals. This actually occurs at integral mc points. In addition, the 1 mc beats with 8600 kc to produce beats ending in 0.6 mc, such as 9.6, 10.6, 11.6, etc. Furthermore, beats are generated at 3.3, 2.3, 1.3 mc, etc. If these markers are correctly interpreted, you will have numerous points to calibrate and compare with other frequencies.

In every case, the precision of your beats depends upon the precision of the crystal. Crystals selling for as little as 49c are usually accurate enough for most purposes. Many stores are still selling Signal Corps rf crystals at low prices.

Several manufacturers grind crystals to any specified frequency at a reasonable price. A 5000-kc crystal is a handy value for the beatnik.

The beatnik circuit for generating beats with a pair of crystals has been combined in the same box with a two-transistor generator which takes crystals in the 400–500-kc range. It was described in the November 1956, issue of RADIO-ELECTRONICS, page 37, Fig. 4. Both circuits are shown in Fig. 2.

The dual instrument uses an external 6-volt power supply. There are separate power and output jacks for each oscillator. Use the proper power and output jack for the desired band (low frequency or high).

For low frequencies, a two-lead conductor connects the beatnik to a receiver antenna and ground for maximum signal. The beatnik chassis corresponds to ground. For high frequencies, the ground loads the beatnik too much and should be eliminated. Use only a connection from the beatnik to the receiver antenna for a strong high-frequency signal.

Each oscillator is assembled onto separate plastic subchassis which are mounted inside a 3 x 2 x 1½-inch metal box.

END

R1—3,900 ohms
R2—1,800 ohms
R3—4,700 ohms
R4—15,000 ohms
R5, R7—120,000 ohms
R6, R8—1,000 ohms
All resistors ½-watt 10%
C1, C2, C6—.005 μf, ceramic
C3, C7—.001 μf, ceramic
C4, C9—12 μμf, ceramic
C5, C10—56 μμf, ceramic
C8—220 μμf, ceramic
D—1N34
J1, J2, J3, J4—phono jacks
V1—2N169
V2—2N170
V3, V4—2N503
XTAL 1, XTAL 2, XTAL 3—selected for desired frequency
Case—3 x 2 x 1½ inches
Miscellaneous hardware

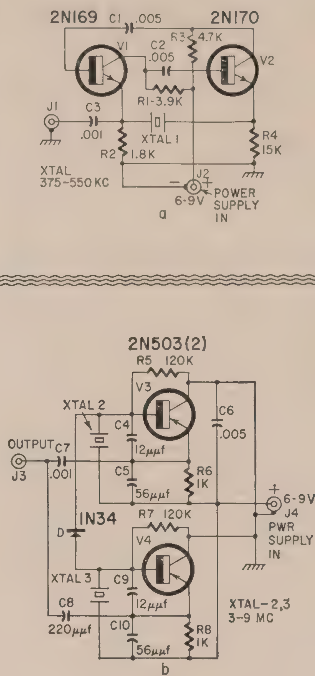
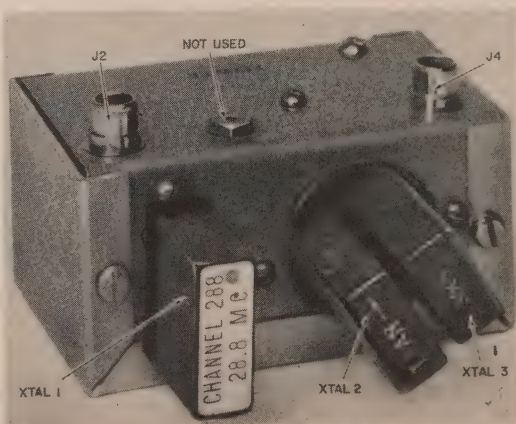


Fig. 2—Circuit of the oscillator. High-frequency and low-frequency sections are shown separately.



Three crystals plug into the beatnik.

By W. G. ESLICK

Basic servicing tricks

These radio hints and techniques are all "old stuff" but you'd be surprised how new most of them are to the apprentice in your shop.

THE service technician just out of training runs into many jobs he can't seem to solve. He just hasn't the feel of things yet and needs a little practice. So let's take a common ac–dc receiver and go through the common troubles.

In many ac–dc radios, the heaters are in series. An intermittent heater in such a set can be hard to find but doesn't have to be. Simply pull the chassis from the cabinet and, taking one tube socket at a time, bridge a small neon lamp or a 6-watt 110-volt lamp across the heaters (Fig. 1). If the lamp lights the next time the heaters wink out, you have the lamp connected across the bad tube. Oftentimes an ac voltmeter will show up the abnormal filament even while it is operating. If voltage across one heater is much higher or lower than across others of the same rating, suspect that tube.

If several tubes light extra bright while one or more others don't light at all, look for a heater–cathode short. A tube tester will usually reveal this fault. If not, tube substitution will.

Next most frequent trouble seems to be bias trouble in the audio output stage because of a shorted tube or coupling capacitor. If the output tube has a cathode resistor, check grid voltage between grid and ground. Hook up your voltmeter and momentarily pull the tube. If you don't get a positive voltage indication, the tube is presumably at fault. If you do get a positive indication, clip off the coupling capacitor at the grid and double-check by connecting the voltmeter from the clipped end of the capacitor to ground (Fig. 2). In the rare case it could be leakage in the socket.

If the tube has fixed bias (grid coupled to the negative power supply through a grid resistor or resistors), check coupling-capacitor leakage by placing the voltmeter's positive lead on the grid and the negative on the far end of the grid resistor (Fig. 3).

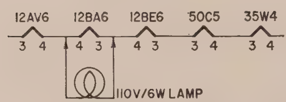


Fig. 1—A lamp across a filament will light if the filament is open.

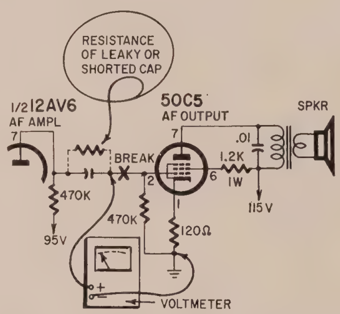


Fig. 2—Check for a leaky coupling capacitor in a cathode bias output stage.

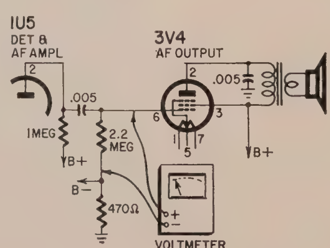


Fig. 3—Check for leaky coupling capacitor in a fixed bias stage. This type circuit is usually found in 3-way portables and is rarely seen in new sets.

Direct shorts are spotted by checking resistance from output-tube plate to ground and screen grid to ground. Also, note your resistance readings. A considerably lower reading on the plate than the screen indicates a short in the plate circuit (plate bypass or tone capacitor shorted) or rarely, a high-resistance output transformer primary. In some circuits, cutting various B-plus leads to isolate circuits makes the short simpler to find. Don't overlook the possibility of shorts in if and oscillator transformers.

The grid-grounding technique

With the volume control turned up, touch each grid and plate with the tip of a screwdriver blade (insulated handle, of course). Start from the output tube and work your way back. This will make a loud noise in the speaker if the stage is good. This is a rough stage-by-stage check and isn't to be relied on 100%. If the oscillator transformer is open (grid to cathode), this test will cause a loud noise in the speaker, showing the rf grid section is hot. If the coil has a tickler winding for the plate, the oscillator's anode grid or plate will measure zero volts.

Another fault, especially where an open-end winding serves as coupling capacitor to the oscillator grid, is that oscillator won't fire. Clip the lead and install a 75- or 100-$\mu\mu f$ mica capacitor from the tap going to the tuning gang to the oscillator's grid. To check shorts in the tuning gang, unhook the oscillator section (usually it is a few ohms to ground or B-minus). If in doubt, unhook the rf section too and check both sections of the tuning gang.

Capacitor troubles

To find and burn out shorts, unhook the gang from the receiver. Then connect a 100-watt bulb in series with the line and connect each section of the gang in turn. As you rotate the gang, the bulb will light whenever the capaci-

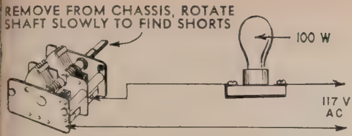


Fig. 4—Checking a tuning capacitor for shorts. Simple hook-up will burn out minor ones.

tor shorts and the line voltage will burn out minor shorts (Fig. 4). [Watch this one—you have dangerous line voltage all over the bench.—*Editor*]

Straighten tuning capacitor plates if they are touching. Don't forget to use a cleaner on the ends and a drop of oil in the bearings. Some gangs are insulated from chassis and are tied back to avc. Be sure the capacitor isn't shorting to chassis and grounding the avc.

Check avc with a vtvm. If locals are distorted and distant stations are clear, shunt the avc filter resistor with a 2- or 3-megohm resistor and the avc load with a 0.5- to 1-megohm resistor (the volume control is often the load resistor in small sets, but not always). If this clears up the trouble, check each resistor with an ohmmeter (isolating one end). Also, check the avc bypass capacitor for leakage or, better, replace them outright. (Even several megs leakage can cause trouble here.) An rf, mixer or if tube can cause avc trouble if it is leaky or gassy.

Bridging filter capacitors with a good one will show up bad filters. Sometimes the leakage is between sections of a multiple-section capacitor. In this case, clip out one section and connect a good capacitor in its place. In rare cases (nowadays anyway) leakage between the capacitor case and ground causes bad hum. On sets that use voltage doublers, connect a voltmeter across capacitor to find the faulty one.

This also applies to printed-circuit sets, though they may be harder to work on. Use a sharp knife or razor blade to cut and isolate circuits. You can solder the breaks later.

On car radios, pulling and inserting a tube quickly will pinpoint the dead stage. It is best to replace the buffer capacitor when replacing a vibrator, but remember your customer may not want to spend that much. Check current drain as shown in Fig. 5. If the current is two-thirds or less of fuse rating, you can probably take a chance. If current is higher, check the buffer and the power transformer.

Also check for broken or melted bypass capacitors on the low-voltage A-circuits. They can cause vibrator hash.

If some of the tubes are lit and others are not, a broken connection in the heater line is the trouble. But if everything is dead and current is getting to the radio, check the on–off switch—it's a big offender.

Miscellaneous

An open electrolytic capacitor will usually make a radio motorboat or squeal. Be careful of coil leads; they are very fragile. In ac–dc battery sets, a 25-ma rectifier with leads—so it can

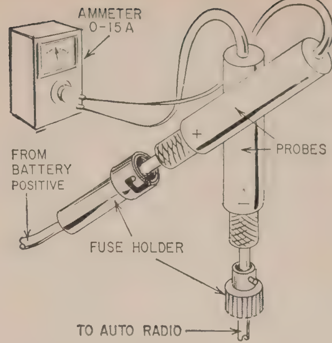


Fig. 5—When changing a vibrator, a quick check of current being drawn by the auto radio gives a rough idea as to the need for a new buffer capacitor.

be bridged across the rectifier in the set—is a handy gadget. In the rare cases where a new rectifier and filters and a check of the heater dropping resistor do not cure the trouble, take a 12,000-ohm 2-watt resistor and bridge the heater dropping resistor. Check with a voltmeter to see if this raises the voltage on the mixer heater to the proper value. If not, try 10,000 ohms.

Don't forget to inspect wires where they pass through chassis holes or bend around sharp corners or objects. This has caused lots of troubles in all makes of sets. Also don't overlook grounds connected to the chassis with a soldering lug or rivet. We have seen many troubles that others have given up on that turn out to be poor grounds.

Transistor radios

A signal tracer is a handy instrument and almost a must for transistor radios. A set of good schematics is a big help and a time saver. A good transistor checker is a must, too.

Checking voltages (resistance checks are almost useless due to transistor resistance) and also battery current drain (against the schematic) is a good beginning. Signal tracing from base to collector (sometimes the emitter in rf stages) will pinpoint the bad stage. A good instrument is a signal generator that emits rf and audio at the same time.

A broadly tuned stage (as the if slug is turned) is a good sign (but not always) that the transistor has high leakage. A normal transistor stage will be broader than a tube stage. A few experiments with good sets will show you what to expect.

Common sense, a little theory, a little circuit knowhow, proper instruments, diagrams, data and proper tools will fix any set. *Don't tear a set to pieces till you know what it is or is not doing*, and have a fair idea of where to start looking. One of the greatest offenders I've known was a young man who used to fill in Saturdays in a shop where I worked. He would tear the set completely apart and leave it. When I came in Monday, I usually found the fault didn't require dismantling, and had to put the set back together. END

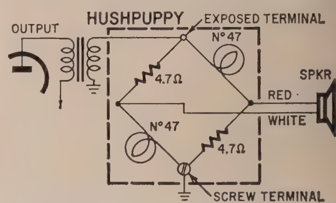
Hushpuppy in speaker circuit.

Hushpuppy for squelch

WE were attracted recently by an ad that started "What Price Standby Silence?" and offered the above-named device at $4.95 ("list price $9.95") as a squelch device for Citizens-band radio receivers. We sent for one.

The Hushpuppy was a strange-looking device intended to be attached at the speaker terminals. Much clipping away of plaster-of-paris revealed the works: two pilot lamps, two 4.7-ohm resistors and a terminal strip.

A look at it shows a variation on a very old volume-expansion circuit, described by de Rosa in the 1930's. The two 4.7-ohm resistors and the two pilot lamps form a bridge fed by the output transformer, with the voice coil across



Hushpuppy mounted at speaker.

it. At no signal or with small signals, the lamp filaments remain cold and, since their resistance is in the same order as that of the resistors, the bridge is near balance and little if any signal goes through the speaker voice coil, both ends of the voice coil remaining at the same voltage while current passes through the resistors and lamps in parallel. With stronger signals, the lamp filaments heat up and their impedance increases to a considerably higher value than that of the fixed resistors. The bridge is unbalanced and current flows through the series resistors and the voice coil.

Unfortunately, it takes a considerably higher setting of the volume control to get the same output when the Hushpuppy is used. Both weak stations and noise are squelched together. END

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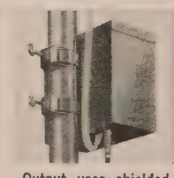

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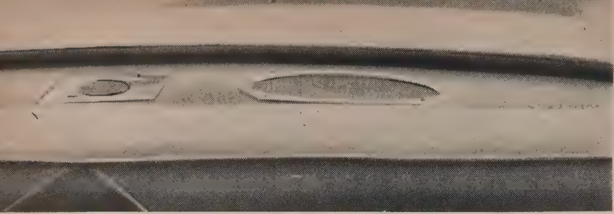
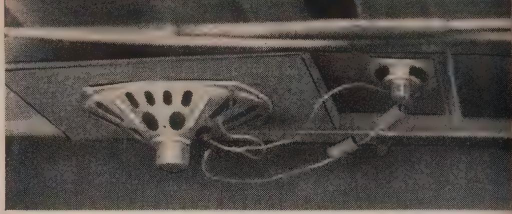


The completed system.



Arrangement inside trunk looks like this.

Install a wide-range speaker system in your car

By STEPHEN A. KALLIS, JR.

PITY the poor audiophile who owns a car, especially if he has to take long trips. Accustomed to high-quality music, he finds the output of the family buggy's radio is usually far below his standards. Eventually, the substandard sound will probably get the best of him, and he'll decide to do something about it. Said something may be an FM tuner or something even more exotic, depending on his skill and fanaticism.

No matter what he decides to do, however, he will need an adequate speaker system to enhance the result. Whatever design features Detroit puts into cars, audio engineering is not included, so it becomes very difficult to fit anything into a car. For example, while it would be nice to feed audio through a 15-inch coaxial or triaxial speaker, it is almost impossible to find a place to install such a speaker especially if you expect to fit passengers in as well. Thus we are forced to use a system which will fit within the limits Detroit imposes on us.

The speaker system described here is specifically designed for automobiles, and primarily as a foundation for a mobile high-fidelity system. In addition, it can be connected to the car radio for better AM sound until you get your other mobile high-fidelity components.

Speaker locations are pretty well predetermined. The only place they can be placed is in the rear-deck area. Some provisions have already been made in most modern cars for a speaker there, but these are inadequate.

The size of the woofer is also predetermined. The largest speaker that can be employed with this design is a 6 x 9-inch oval. A 3-inch tweeter completes the speaker complement. For the best response, the enclosure should be a base-reflex type. Cars have provision for 6 x 9 speakers, but do not lend themselves to reflex design so we used a modified arrangement somewhat similar to the R-J and Lafayette's Eliptoflex systems. The speaker is on a baffle board set back from the deck. The area described by the perimeter of the two woofer holes (the one in the deck and the one in the baffle board) and the space between them determines the port area. For this reason, the two holes should be the same size—the maximum inside size of the speaker. The board is set back 1 inch, fiber washers being used as spacers (see Fig. 1).

The mechanical work

The simplest method of obtaining the correct-size elliptical holes is to use the grille plate as a guide. Simply trace the correct oval, using the inside of the grille rim as a template.

The baffle board itself should have certain features. It should measure at least 9 x 14 inches. The speaker is mounted in the center. Use ¾-inch plywood for the baffle (Fig. 2).

The grille is very important. Many radio supply houses supply grilles, but most of them are unacceptable. The proper grille consists of an elliptical metal rim and a piece of porous fabric. A metallic grille or one covered with fancy metalwork may look prettier, but it hampers proper sound radiation by cutting down the effective port area. When buying a grille, make sure the fabric is porous. If it is not, make sure you get a grille with a separate frame, as you will have to buy grille cloth for it separately.

The tweeter is mounted flush with the deck, as it needs no reflex design. Any 3-inch PM speaker will do as long as it has the same impedance as the woofer (both should be 3.2 ohms). It is connected in parallel through a simple capacitance crossover consisting of a 10-μf capacitor. (If you can obtain only electrolytic capacitors, buy two 20-μf units and connect them back to back as in Fig. 3.) The two speakers should be phased beforehand.

Wiring is simple. Car manufacturers take advantage of the fact that a car has a metal chassis and ground one of the two audio leads. So only a single lead has to be run, and the other post of the speaker grounded. Depending on your choice, you can either use a three-position switch or a fader control for balancing the sound between your front (original) and rear speakers. If you plan to use an amplifying system other than the one for your car radio, add a spdt switch between the audio output and the fader or speaker switch (S in Fig. 3).

The rear-deck reflex makes a good weekend project. It can be the first step toward some excellent highway listening. And it makes the original car radio sound better! END

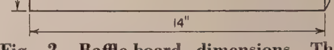


Fig. 2—Baffle-board dimensions. The minimum size in indicated.

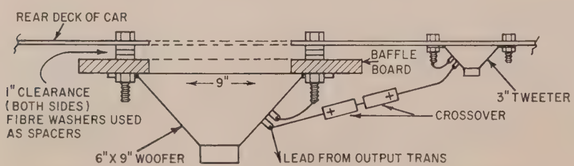


Fig. 1—Cross-section of speaker mounting and wiring.

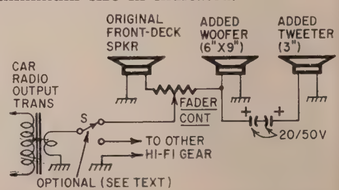


Fig. 3—Circuit of the improved speaker system.

Lucky Hunts Low High Voltage

Lucky cures one trouble and introduces another. Net result, he learns a few things about horizontal oscillators.

By WAYNE LEMONS

LUCKY was having trouble with a capital T—a Truetone TV with very little high voltage. In fact, it had just a slight reddish arc when you touched a screwdriver to the 1B3 plate cap. The set used a conventional phase detector, multivibrator, horizontal oscillator and sweep system. He had checked all the tubes and then, to be on the safe side, had replaced each one. Still there was not the slightest trace of high voltage at the picture-tube anode. He didn't trust test equipment too much and, as his employer had noted sourly on a few choice occasions, you couldn't trust the test equipment after he used it either! He decided, however, to check the grid drive on the 6BQ6. It seemed ample—21 volts negative. To him it meant that the horizontal oscillator was OK. He'd just have to look further.

Lucky checked the screen voltage on the 6BQ6; it was 145 volts. Nothing wrong there. He also measured the boost voltage; it was 320 volts. The B-plus was 290 volts. "Not near enough boost," he said, half aloud. He knew this was to be expected. He *had* learned long ago that a boost-voltage measurement didn't really tell him very much about *what* was wrong in the horizontal sweep system. About all it really told him was that something *was* wrong, an obvious fact of which he was already painfully aware.

He mumbled to himself, "Must be the flyback or maybe the yoke." He remembered that he could substitute another yoke without actually mounting it, to see if the trouble was in the old yoke. He disconnected the horizontal leads from the yoke and, taking a new yoke with about the same inductance from stock, connected it in place of the set's yoke. He turned the brightness down to make sure he wouldn't burn the picture-tube phosphor if the high voltage came back on. He needn't have bothered. Seemed as though the arc on the 1B3 cap might be just a little bigger but he couldn't be certain.

"It just has to be the flyback!" he mumbled; he was just sure. He stole a glance to see if Cy—the shop owner—was watching. He had been "just sure" too many times before, only to get a lecture from Cy on finding the trouble *before* replacing all the parts in the circuit.

Lucky hesitated a moment and then decided that he better ask for a little help. He turned toward Cy and said half apologetically, "I got troubles, boss."

"That so?" asked Cy.

"This darn thing don't have any light on the screen—no high voltage."

"What have you done so far?"

Lucky told him.

"Sure the oscillator is OK?"

"Negative 21," replied Lucky.

"Means nothing," Cy said.

"What do you mean?"

"Well, the frequency could be way off and still there would be drive at the grid of the horizontal output tube."

"You mean just because there is a drive voltage on the 6BQ6 doesn't mean the oscillator is all right?"

"Exactly. If the oscillator frequency is off, then there may not be enough efficiency in the high-voltage system to develop high voltage. Think what might happen if the oscillator is more than a couple of thousand cycles high or low."

"I get a little arc on the 1B3."

"I know, you told me, and that's partly why I suspect that the trouble might be in the oscillator. Of course, you could be right. It could be the flyback, but let's make some other checks first and see if we can't find out."

"Looks like with that little arc on the 1B3 cap that I should get a little high voltage on the picture tube," said Lucky.

"It would seem that way at first thought," returned Cy, "but remember that voltage for the 1B3 heater comes from a winding or two around the flyback. If the efficiency of the sweep system goes down, there might not be enough left to light the 1B3."

"And so no high voltage."

"Right."

"But how can we tell if the horizontal oscillator is off frequency or not?"

"Well, it isn't easy unless we have a special instrument," said Cy. "We might make a fair calculation using the scope, but that can be tricky."

"Any other way?"

"We could use a substitute oscillator, but we might find out easier."

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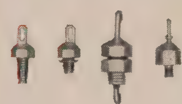

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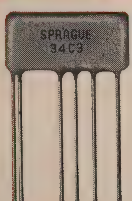

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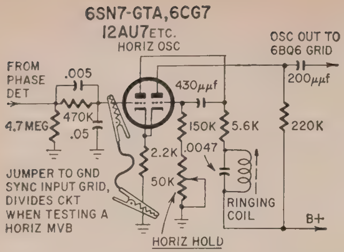


Fig. 1—Grounding the oscillator's input grid separates it from the phase detector and keeps phase-detector troubles from affecting the oscillator.

"How's that?"

"Well, as you should know, quite often an off-frequency oscillator is caused by a defect in the phase-detector circuit. There is an easy way to find out when the horizontal oscillator is a multivibrator circuit like this one."

"Oh, I remember, I think you told me once."

"Once!" Cy exclaimed. "I've probably told you a hundred times!"

Lucky ignored the outburst and continued, "We can ground the grid of the oscillator that connects to the phase detector."

"How come you never thought of that before?"

"It just came to me." Lucky grinned.

Lucky got a jumper with clips on either end from the collection hanging on a nail at the end of the bench. He clipped one end to the chassis and the other to the sync input grid on the 6SN7 oscillator (Fig. 1). He turned the set back on and they waited for it to warm up. The raster came on with a bang.

"Well, I'll be," Lucky muttered.

"Doesn't look like we got flyback trouble, does it?" Cy couldn't keep from gloating a little.

"I think I can finish the job now," said Lucky.

"OK, it's all yours, but remember that set has to be delivered this afternoon."

"I know what causes this trouble and I'll have it fixed in no time."

Cy went off to work on another set and Lucky went to the tube rack. He picked out a 6AL5 and replaced the phase detector. There was no improvement in the high voltage.

"Then it's got to be the capacitors," he said to himself. "No use taking chances, I'll replace them all."

An hour later, Lucky was still working on the set or, to be more accurate, was staring at it morosely. Cy looked over his shoulder. "Same set?" he asked dourly.

"I just can't figure it out," Lucky admitted. "I've put in a new 6AL5, I've changed the capacitors and checked the resistors and I still only get high voltage when I short the oscillator sync grid."

"Well, obviously something is unbalancing the phase detector. Have you measured the voltage on the sync input grid of the oscillator?"

"Sure have. It's 11 volts positive. Funny thing though, I don't have any drive on the 6BQ6 *now* until I short out the grid of the oscillator."

"With that much positive voltage, I doubt if the oscillator is running at all. Anyway that 'funny' thing that happened should tell you something."

"What's that?"

"It should tell you that you changed the circuit somehow."

"I thought so too," said Lucky, "but I've rechecked the wiring a dozen times."

"You sure the 6AL5 you put in is good? Unbalance here can cause trouble, though it doesn't happen as often with a tube as with the semiconductor diodes."

"That's the third 6AL5 I've put in."

"Well, you also replaced the most likely culprits, the .001 coupling capacitors from the sync inverter" (Fig. 2).

"And also the bypass at the plate and cathode of the 6AL5 where the sampling pulse from the flyback transformer is fed in."

"Looks as if we're going to have to get out the scope," said Cy.

He turned on the scope. Using a low-capacitance probe, he touched the sync input plate terminal of the 6AL5 phase detector. The waveform on the scope was clean with an amplitude of about 20 volts peak to peak. He moved the probe to the sync input cathode (in the other section of the 6AL5).

The waveform should have been

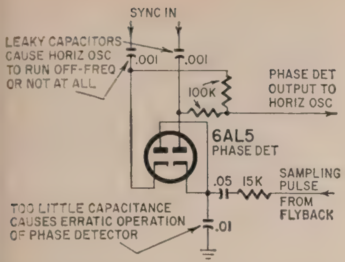


Fig. 2—Capacitors can make trouble in the phase detector. Note the possible trouble points.

about the same except reversed in polarity. What Cy and Lucky saw was almost unrecognizable in form with a peak-to-peak of over 35 volts.

"Either we're getting a peculiar output from the sync phase splitter or from somewhere else," mused Cy.

"How can we tell?" Lucky asked.

"Let's pull out the 6AL5 and check again."

When they did this, both test points had almost identical pulses except with opposite polarity.

"We're getting close," said Cy.

"What is it?" asked Lucky anxiously.

Cy didn't answer. Instead he moved a capacitor, looked at it, smiled wryly, picked up the cutters and clipped it out. He still didn't answer when Lucky asked if the capacitor was bad. Cy just reached for a .01-μf capacitor, soldered it in, and turned the set back on. The raster came on bright with a locked in picture.

"Was *that* capacitor bad?" Lucky wanted to know again.

"I don't know," said Cy.

"What do you mean you don't know?"

"I don't know whether it is bad or not, but I doubt if it is. But I can tell you one thing."

"What's that?"

"It's a .001."

"Yeah, I know," said Lucky, "I just put it in."

"Yeah, I know," growled Cy. "You should check the capacitors you're installing. Or better yet *don't* install a capacitor if the old one checks good. Did you check the leakage of the capacitors you replaced?"

"One was pretty bad," said Lucky, "so I thought I had better not take any chances with the others. What happened?"

"Well," Cy said, as if resigned to his fate, "an .01 is used to bypass the sampling pulse in this circuit. You obviously replaced the sync feed .001 that was giving the original trouble *BUT* you replaced this .01 with a .001 also and you *created* a new trouble that looked almost the same as the original one. When that kind of thing happens, it can throw even a good technician for a loop."

"You're telling me," Lucky said, Cy thought maybe a *little* sheepishly. "Just what happened?"

"Look at the circuit" (Fig. 3), commanded Cy. "You'll see that the sampling pulse from the flyback is fed through an R-C network to one cathode and the opposite plate of the 6AL5. Installing the wrong capacitor increased the sampling pulse about 10 times. The increased positive pulse caused the right side of the 6AL5 to conduct more than normal. The extra voltage didn't affect the left side of the 6AL5 because the pulses were fed to the cathode, as you saw when we looked at the waveform with the scope."

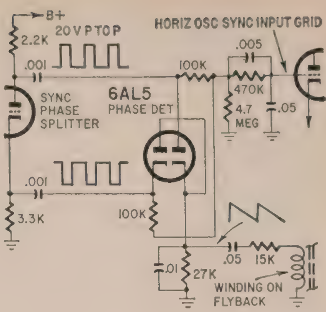


Fig. 3—Phase-detector circuit causing Lucky's Truetone trouble.

"And that caused the unbalance and the excessive voltage at the oscillator tube," finished Lucky.

"After a deal like that I think I should change your name from Lucky Shott to Pott Shott. You land on a circuit just like a greedy hunter lands on quail." END

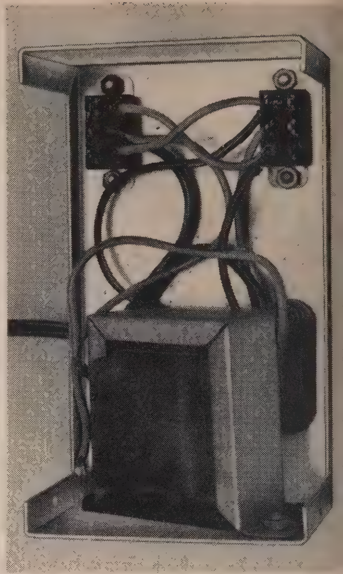
Simple voltage control box

By JAMES A. FRED

HOW many times have you wanted to raise or lower the electric line voltage in your house? Several devices are made for this purpose, but they are all quite expensive. To take care of this situation we designed a circuit using a transformer and two slide switches.

The theory that makes the circuit simple and effective is that of series-aiding and series-opposing alternating-current circuits. This theory states that voltages of the same polarity oppose and that voltages of opposite polarities aid each other. This can best be illustrated by Fig. 1. Here we see a transformer with a primary and a secondary winding (Fig. 1-a). We'll assume that the voltage on the secondary is 10 volts. At any given instant during every cycle of our alternating current, points 1 and 3 will be negative and points 2 and 4 will be positive. Now, if we connect 2 and 3, we have series-aiding and get a total of 125 volts between 1 and 4. This is the sum of the 115 volts from the line, plus the 10 volts from the secondary of our transformer (Fig. 1-b). Now let's go back to Fig. 1-a again. This time we connect points 1 and 3 and points 2 and 4. This places two minus points together and two plus points together, giving us a series-opposing circuit and a total output voltage of 105—the 10 volts from the secondary being subtracted from the 115 volts of the line voltage as in Fig. 1-c.

As you see, we can get two voltages



There are only three basic components inside the case.

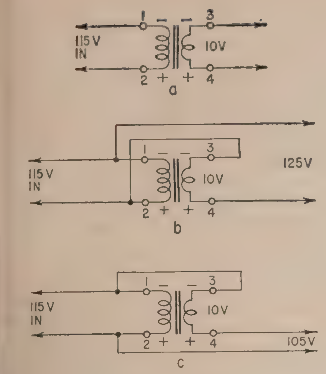


Fig. 1-a—Basic transformer; b—hookup for series-aiding and (c) for series-opposing.

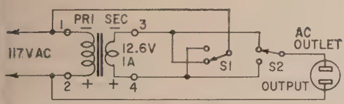


Fig. 2—Circuit of voltage control box.

with only one low-voltage transformer. We can go a step further and also get the line voltage, giving us three voltages. This is a highly desirable combination, and we wanted to take advantage of it.

We considered several switching circuits, finally designing a simple one using two single-pole double-throw slide switches (Fig. 2). Two slide switches are wired to a transformer. By putting both switches in the up position, we get about 125 volts output. By putting both of them in the down position, we get about 105 volts. By putting them in opposite directions (either one up and the other one down), we get the line voltage as the output.

As you can see from the photos, the voltage control box is made as simple as possible. You can dress it up if you like by adding a line switch and a pilot light. This unit has a transformer whose secondary puts out 12.6 volts at 1 ampere. It will handle loads up to 100 watts. We can use such a small transformer on such a large load because the transformer supplies only about 10% of the load.

The transformer, switches and receptacle are mounted in a 2¼ x 3 x 5-inch aluminum box. The parts are crowded, but they run cool when in use.

There are two precautions to take when wiring the unit. **Do not make any connections to the case or it will be hot.** Also, if you cannot identify points 1, 2, 3, 4 on your transformer, you need not worry. Just wire it up, observing the primary and secondary wires, and connect an ac meter or light bulb to the output. Push both switches up. If the voltage doesn't increase or the light bulb get brighter, reverse the connections to the primary winding. This is the only change you need to make. END

CARE AND HANDLING OF TUNNEL DIODES

A dozen do's and don'ts that extend the life of those expensive negative resistance diodes

By RUFUS P. TURNER

SEVERAL makes and types of tunnel diodes can now be bought over the counter. We may expect, therefore, that a great deal of experimenting with this interesting new component is under way. But the tunnel diode is still relatively high-priced, so many an experimenter for the time being will own only one. To avoid damaging this one diode and to keep it operating as it ought to, it must be handled properly. Until tunnel-diode prices drop to 50 cents each, the experimenter will want to be extra careful.

What must be done? Here are a few simple do's and don't's, based upon good semiconductor practice and my own (sometimes sad) experience with tunnel diodes.

1. Use a low-resistance dc bias supply. The dc bias voltage must be supplied by a source whose internal resistance is lower than the negative resistance of the diode. Depending upon diode characteristics, the supply resistance should be no higher than 5 to 20 ohms. Use the lowest obtainable value. A satisfactory method is to take the bias across a low-resistance leg of a stiff voltage divider operated from a battery or well filtered rectifier. Make a part of the higher-resistance leg of the divider variable so the bias voltage may be adjusted. But keep a part of the higher resistance fixed so that there is no danger of applying the full battery voltage to the diode.

2. Check the dc operating point. That is, run through the diode conduction characteristic (Fig. 1) by varying the dc bias voltage and observing the resulting current. (An identical current reading may be obtained along both the positive and negative slopes but at different voltages. It is necessary to know whether current is increasing or decreasing with voltage.) The proper operating point for most experiments is in the negative-resistance region, where current decreases as voltage is increased. Thus, in Fig. 1, the same current flows at point A, (voltage E_1), point B (E_2) and point C (E_3), but only point B is in the negative-resistance region.

3. Take into account the voltage drop across the current meter when testing a diode. The milliammeter or microammeter used in the test has a definite internal resistance which introduces a voltage drop into the circuit. Thus, in Fig. 2, the output voltage across the 10-ohm leg of the voltage divider (R2) is 150 mv—one-tenth of 1.5 volts—and the observed current is 0.5 ma. However, the diode bias is not 150 mv, because 0.5 ma produces a voltage drop of 25 mv across the 50-ohm milliammeter, but is 150 − 25 = 125 mv. Since the internal resistance of the meter is in series with the diode, it can influence the latter's response. Therefore, always use the lowest-resistance current meter obtainable.

4. Don't test a diode with an ohmmeter. The voltage applied to the diode by the ohmmeter may be high enough to damage the diode. Furthermore, this simple test may not be as informative as it sometimes is when testing conventional diodes and rectifiers, since the front-to-back resistance ratio of the tunnel diode *normally* may not be high.

5. Watch polarity. At the normal bias voltage, reversing the diode should cause no damage, but it will prevent normal operation. For negative resistance, the diode *must* be forward-biased: anode positive, cathode negative.

6. Don't use excessive input-signal voltage in diode amplifiers. Excessive signal-voltage peaks will drive the diode out of its negative-resistance region. Linearity is enhanced when the peak signal voltage is small with respect to the dc bias voltage.

7. Protect the diode from surges. Protect the diode from destructive kickback voltages by installing a safety device (varistor, surge-limiting resistor or reverse-connected germanium, silicon or selenium diode) across any high-inductance coil in the circuit (Fig. 3). High kickback voltages produced by collapse of the magnetic field of a high-L coil can wreck a diode in a fraction of a second.

8. Don't exceed maximum recommended temperature. Consult the diode manufacturer's data sheet for the maximum temperatures at which the diode may be operated or stored. If the temperature ratings *must* be exceeded, apply any derating factors specified by the manufacturer. Usually, this involves reducing bias or signal voltages.

9. Don't exceed maximum rated power dissipation. The dc power input (P) to the diode is the product of the bias voltage and the resulting current: $P = EI$, where P is in watts, E in volts and I in amperes. If E is expressed in millivolts and I in milliamperes, $P = .001EI$ milliwatts. Consult the manufacturer's data sheet for maximum permissible power dissipation at the desired operating temperature. Excessive dissipation can shift the diode operating point, upset operation of a circuit or destroy the diode.

10. Don't operate the diode in a strong alternating magnetic field. A strong ac magnetic field (either audio-frequency or radio-frequency) may induce damaging currents in the diode structure.

11. Do heat-sink when soldering or welding. This is a precaution with all diodes and transistors. A simple method is to hold the pigtail with pliers (between the point of heating and the body of the diode.) *until the joint is completely cooled.*

12. Do check the circuit carefully. Check all wiring for correctness before installing the diode. Then check again before switching on the power. It is good practice to install the diode in a circuit last and to remove it first. END

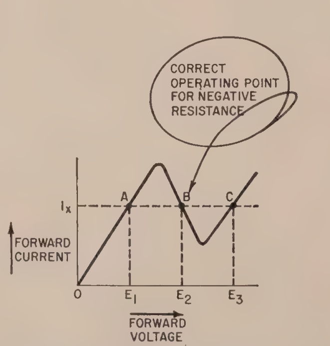


Fig. 1—Conduction characteristic—current I_X flows at points A, B and C, but only point B is in negative resistance region.

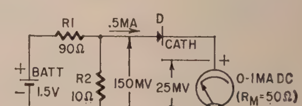


Fig. 2—Tunnel-diode test circuit.

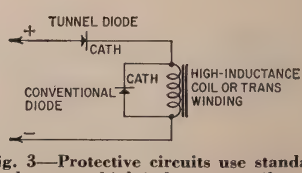


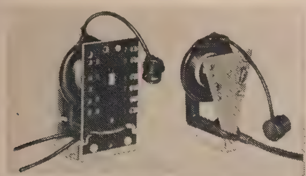
Fig. 3—Protective circuits use standard diode across high-inductance coils.

new PRODUCTS

MINIATURE CERAMIC TRIMMER CAPACITOR, *Style 538.* ⅜-in. diameter. Operating temperature

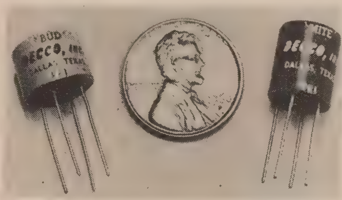
to 125°C. 200 working volts dc. Q factor at IMC 500 minimum. Flash-test voltage 400 dc.—**Erie Resistor Corp.,** 644 W. 12th St., Erie, Pa.

FLYBACK TRANSFORMERS. *HO-320* replaces RCA 103839 and Sylvania 241-0046/48; *HO-326,*



Meck Part No. THC-10021; *HO-332,* Magnavox Part Nos. 360580-1 and 360604-1, *HO-333.* Magnavox Part No. 360700-1/-2.—**Chicago Standard Transformer Corp.,** 3501 W. Addison St., Chicago 18, Ill.

TRANSISTOR TRANSFORMERS, miniaturized to save space. *Bud* 5/16 in high; *Mite,* ⅜-in di-

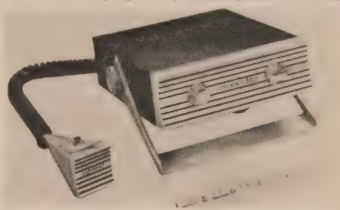


ameter. 42 designs in either style. Encased in drawn steel cans with nickel-alloy leads on standard 0.1-inch spacings for printed-circuit mounting.—**Decco, Inc.,** 2025 Farrington, Dallas, Tex.

UTILITY AC POWER SUPPLY, *HP-20,* for radio amateur. Furnishes filament, plate and bias voltages when converting mobile amateur gear to fixed-station operation. 8 amps at 6.3 volts ac or 4 amps at 12.6 volts ac. Plate power

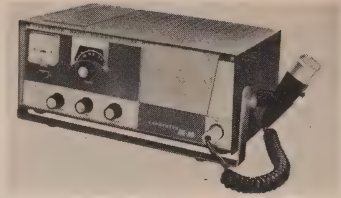
600 volts dc at 200 ma or 600 volts dc at 150 ma and 300 volts dc at 100 ma. Separate bias supply for 130 volts dc at 30 ma.—**Heath Co.,** Benton Harbor, Mich.

CITIZENS-BAND TRANSCEIVER, *Osborne 300* is 1⅞ x 6 x 7 in. 9-transistor circuit. 4-channel selector with plug-in crystals. Operates on any



of 23 allocated Citizens-Band channels. All-metal die-cast case.—**Osborne Electronic Sales Corp.,** 13105 S. Crenshaw Blvd., Hawthorne, Calif.

CITIZENS-BAND TRANSCEIVER, deluxe, *HE Series.* 5-watt input crystal-controlled transmitter operates on any 4 of 23 channels. Superheterodyne receiver section tunable over all 23 channels with 1-μv sensitivity. Combination S-meter and transmitter plate-current indicator. Built-in 115-volt ac/12-volt dc power supply for

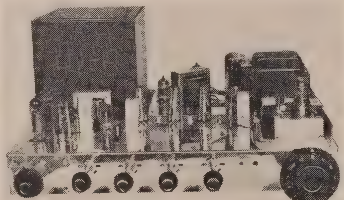


fixed operation.—**Lafayette Radio Electronics Corp.**, 165-08 Liberty Ave., Jamaica 33, N. Y.

AMATEUR RADIO TRANSMITTER KIT, *DX-60*. 90-watt peak power input. Carrier-controlled phone or CW. Covers amateur bands 80 through

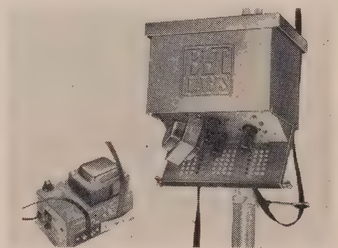
10 meters. Reduced power for novice operation. 13½ x 11½ x 6½. 27 lb.—**Heath Co.**, Benton Harbor, Mich.

HI-FI TV KITS incorporate special circuits. 23-, 24- or 27-inch picture tubes. Critical circuits



preassembled and aligned. Complete step-by-step instructions.—**Transvision**, New Rochelle, N. Y.

MAST-MOUNTED BROAD-BAND TV/FM AMPLIFIER, *Model AB-3*. Remote power supply, *model RP-3*, for reception to full mile from ac power source. Gain 22 db on all vhf TV channels

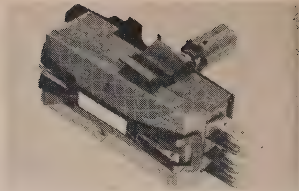


and FM. Impedance—input 300 ohms; output 75 or 300 ohms. Power required—117 volts, 60 cycles; .34 ampere.—**Blonder-Tongue Laboratories Inc.**, 9-25 Alling St., Newark 2, N. J.

INDOOR TV ANTENNA, *models B7M and B7B, Slim-Line Tune-A-Matic.* 4-section telescoping

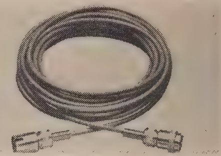
dipoles extend to 36 inches. Tip-proof base. Felt-covered bottom.—**Clear Beam Antenna Corp.**, Canoga Park, Calif.

CARTRIDGES, *models HF-2* and *HF-5*. Twin-stylus turrets for changeover from 33 1/3 or 45 to 78 rpm. 25-db separation between channels. Low stylus mass for tracking at 2 grams. Lead zir-



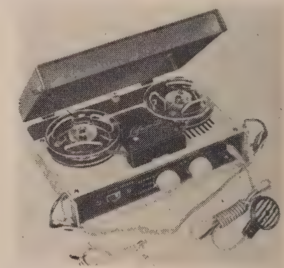
conium titanate elements.—**CBS Electronics, Div.** of Columbia Broadcasting System, Inc., Danvers, Mass.

MICROPHONE PLUG-IN CABLES add extra length to existing cables without tools, wiring or soldering. 25 feet, 2 conductor, shielded. *No. 93-BU94* with Amphenol MC3M and MC3F plugs and *No. 91BU92* with Cannon and XL3-11 and



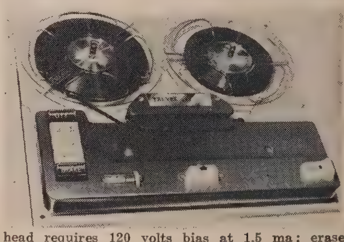
XL3-12 plugs.—**Switchcraft Inc.**, 5555 N. Elston Ave., Chicago 30, Ill.

TRANSISTOR MINIATURE TAPE RECORDER, *RK-125*. Telephone pickup, earphone, patch cord, microphone, 3-inch reel of tape, empty reel and batteries. 3 transistors. 2 x 3-inch PM speaker and amplifier. 6 x 8¼ x 2¾ in. 2½ lb.—**Lafayette**



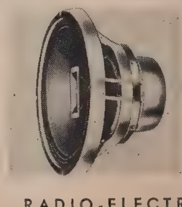
Radio Electronics Corp., 165-08 Liberty Ave., Jamaica 33, N. Y.

TAPE DECK, *Truvox Mark 6*, 3¾ and 7½ ips. 7-inch reels lock on spindles for transit. 3 motors, rewinds at 1,200 feet per minute. Interlocked pushbutton controls. Brake button applies magnetic brakes, off button applies mechanical brakes. Pause button can be locked on. High-impedance half-track mono play, record and erase heads. Available without heads. Record



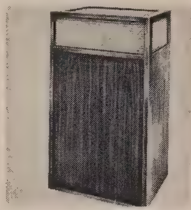
head requires 120 volts bias at 1.5 ma; erase head 150 volts, 11 ma at 50 kc.—**M. Swedgal**, 258 Broadway, New York, N. Y.

DELUXE 3-WAY SPEAKER, *KN-850*, 12 and 15 inches. Vacuum-formed woofer with chemically treated edge suspension. Mid-frequency radiator mounted in center of woofer. Compres-



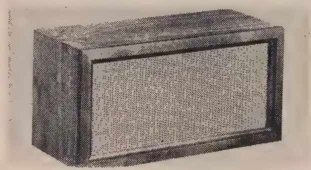
sion type tweeter with phase-correction chamber. 2 crossovers. 5-lb. magnet of specially designed Magloy X. Frequency response 30–20,000 cycles. Free air resonance 35 cycles. Program power capacity 50 watts.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

LOUDSPEAKER, *Citation X,* preassembled, handles 35 watts integrated program material.



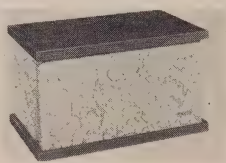
Externally fused. 20 x 14¾ x 36½ in. 70 lb.—**Harman-Kardon, Inc.,** Ames Court, Plainview, N. Y.

SPEAKER ENCLOSURE, *model 128.* 8 inches with vented ports. For horizontal or vertical



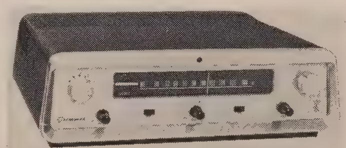
use. 9 x 11 x 19. Oiled walnut, hand-rubbed mahogany, blond or ebony.—**Rockford Special Furniture Co.,** 1803 W. Belle Plaine Ave., Chicago 13, Ill.

HI-FI SPEAKERS SYSTEM, *L-1,* for vertical or horizontal bookshelf use. 15¼ x 9¼ x 8½ in.



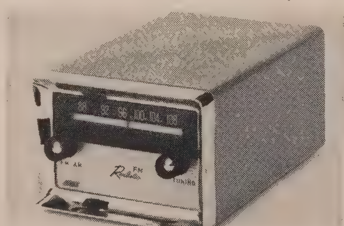
12 lb. Nominal impedance 4–8 ohms. Range 50–14,000 cycles.—**PACO Electronics Co. Inc.,** 70-31 84th St., Glendale 27, N. Y.

FM TUNER AMPLIFIER, *model 510,* 20 watts power. 2 broad-band if stages, dual limiter and



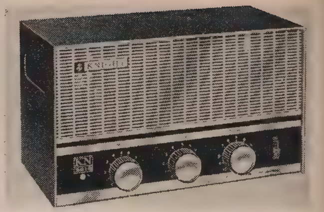
ratio detector.—**Grommes Div. of Precision Electronics, Inc.,** 9101 King Ave., Franklin Park, Ill.

FM TUNER–CONVERTER, *Realistic.* Converts existing AM car radios to FM. 7 tubes, 12-volt



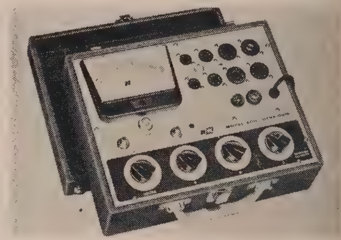
operation, cascaded rf amplifiers, vernier tuning. 7 x 3⅝ x 5½ in.—**Radio Shack Corp.,** 730 Commonwealth Ave., Boston 17, Mass.

10-WATT PA AMPLIFIER, *model KN-3010,* for carnivals, bazaars, auctions and sales demonstrations. Frequency response ± 2 db, 70–10,000 cycles. Output impedances 4, 8, 16 and 500 ohms plus 70.7-volt tap. Tape output jack, single mike



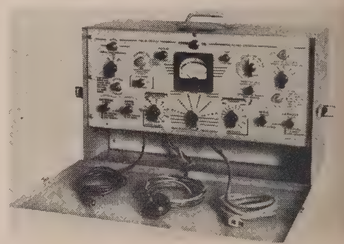
and phono inputs. 6⅛ x 10 x 5½.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

TUBE TESTER, *model 600 Dyna-Quik,* tests all old and new TV and radio tubes, including nuvistors, new 10- and 12-pin tubes and Euro-



pean hi-fi tubes for shorts, grid emission, leakage and gas. 8½ x 11 x 4½ in.—**B&K Mfg. Co.,** 1801 W. Belle Plaine Ave., Chicago 13, Ill.

PORTABLE BEAMER for testing and reju-

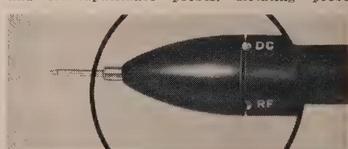


venating faulty and weak TV tubes. Tests for filament condition, element continuity by mutual conductance method, shorts, emission, grid cutoff and grid control, cathode test. Burns out shorts. —**Teletronics Co.,** Ambler, Pa.

VARIABLE AC BENCH SUPPLIES, *models 1073* and *1078,* for production-line testing, quality control and service work. Kit and wired. Output 0–140 volts ac from 120-volt ac line. Current ratings 3 amps for *1073,* 7½ amps for *1078.* Ammeter ranges 0–1 and 0–3 amps for *1073,* 0–2½

and 0–7½ amps for *1078.*—***EICO (Electronic Instrument Co., Inc.),*** 33-00 Northern Blvd., Long Island City, N. Y.

MULTI-PROBE combines dc, ac/ohms, rf and low-capacitance probes. Rotating probe



head with detent action for selection of desired function with ¼-turn.—**Mercury Elcetronics Corp.,** 77 Searing Ave., Mineola, N. Y.

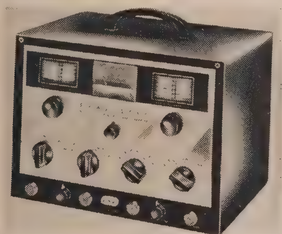
GRID-DIP METER KIT, *model G-15*, acts as variable frequency oscillator covering 400 kc to

250 mc in 8 bands and absorption wavemeter over these frequencies. 2¾ x 7½ x 2½ in. 3 lb. **PACO Electronics Co. Inc.**, 70-31 84th St., Glendale 27, N. Y.

DUAL BIAS TV SUPPLY. Can be used as single

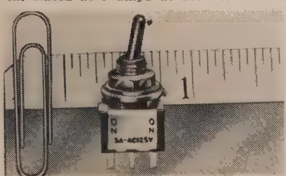
0–20-volt dc supply or as dual 0–20-volt dc supply.—**Sencore**, Addison, Ill.

ALL-WAVE GENERATOR, *model 100*, kit or wired. Combines Wienbridge audio generator and ±1% Colpitts rf generator. Af 20 to 20,000 cycles;



rf 100 kc to 330 mc. Metered and cathode follower outputs. Socket for crystal marker. Vernier tuning. 12 x 5 3/16 x 8½ in.—**Radio Shack Corp.**, 730 Commonwealth Ave., Boston 17, Mass.

TOGGLE SWITCH. Subminiaturized to ½ x ⅜ x ¼ in. Rated at 5 amps at 115 volts ac. Han-

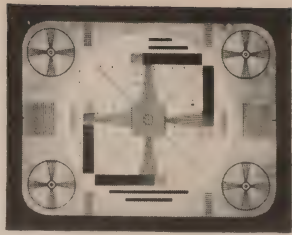


dles up to 100% overload.—**ALCO Electronic Products, Inc.**, 3 Wolcott Ave., Lawrence, Mass.

WIRE STRIPPING AND SOLDERING TOOLS. Stripper with 4 cutting edges for most-used wire

sizes. Soldering tool forked for removing and soldering wires in tight quarters.—**General Electric Co.**, Distributor Sales Operation, Owensboro, Ky. END

All specifications from manufacturers' data.



TV TIPS FROM TRIAD

"—and you can see the 'glitch' on the trailing edge of horizontal sync," said Bill as he pointed to the offending interloper on the scope pattern. "Now, let's review: You're worried about your procedure because of the days you've lost on this job with multiple trouble. It loses horizontal hold on change of channels, or on some station switches, but it's perfectly stable otherwise. It has a slight 'S' in the vertical raster and a variable sync buzz in the audio. Now, what have you done so far?"

"What haven't I done?" muttered Joe under his breath, "so far I've shunted the electrolytics with good units of greater capacity than the originals, I've rebuilt the sync separator, AFC, and horizontal oscillator, with new parts and realigned the sound detector, all with no results."

"Sounds a little long on 'shotgun' and a little short on planning," commented Bill, with a twinkle in his eye, "since the 'glitch' shows up at the video detector it's very likely introduced in the tuner because of poor bypass. The 'S' in the vertical is also indicative of poor bypass, and you may have been fooled by trying to shunt a multiple unit like that four section electrolytic. Install a new high quality electrolytic and I'll wager that your buzz and 'glitch' will disappear. That spike is getting in at the tuner and looks just like sync to the sync separator.

"Whenever you change channels or the station switches in a way that interrupts sync, the AFC system locks in on its own reference pulse and 'hold' is not only lost, but actually locked out if the circuit incorporate a keyed AGC system.

"The hardest lesson I had to learn was to discipline myself to determine the basic problem, and then, one by one, repair the obvious. This meant not only taking positive steps with the filter system, but also not worrying about shading in the raster until I had replaced the covers on the cage or IF strip. If I fixed the visible problems, one at a time, the mysterious elements seemed to take care of themselves, or become easy to identify."

* * *

MORAL: Many a Professional Television Man has had to replace a flyback or other component before he could determine the original reason for receiver failure. "Multiple trouble" is the theme of PTM #4 which will be mailed to people on our mailing list in the near future. If you are not on our mailing list, you can be by writing to ***Renewal Division, Triad Transformer Corp.***, 4055 Redwood Ave., Venice, Calif.

TECHNICIANS' NEWS

FRTSA MEETS ON SERVICE BILL

Harrisburg, Pa.—The Federation of Radio–Television Service Associations of Pennsylvania held an open meeting on the proposed radio–television technician's licensing law. The meeting was open to all technicians and State Senators and Representatives. Representatives of the Department of Public Instruction, Department of Revenue and Attorney General's Office were invited to attend.

LABOR COSTS vs SHOP RATES

The Federal Government, in one of its many aids to small business, has stated that to operate a successful service business a shop should charge 2½ to 3 times the basic wage rate paid to the repairman.

Current union scale in the Seattle area is $3 per hour with an automatic increase to $3.10 per hour next October first. Most employers figure that about 15% additional is their cost of vacations, holidays, payroll taxes, industrial insurance, etc. Really competent technicians are paid premium wages over and above this basic scale in most shops.

Take the basic union scale, which even employers should figure as their own minimum wages. We find by applying the Government recommended formula that hourly rates charged to the customer should be from $7.50 to $9 per hour. Compare this with other services—call your plumber, your oil burner repairman, your electrician and your auto mechanic, and see if these going rates are out of line with comparable services. Check with your own accountant who probably has a good idea of your own costs of doing business.

The hourly shop rate is generally conceded as the minimum home call rate and for each trip when pickup and reinstallation is required.—*TSA Service News*

TESA-MILWAUKEE MEETS

Milwaukee, Wis.—Featured speaker at a recent meeting was Vince Suhajda, vice president and general manager of Stolz-Wicks, Inc. During his talk, he brought out that at present there are over 300,000 TV service dealers in the country, and also that gas stations, drugstores and chain stores are selling $24,000,000 in receiving tubes annually!

Speaker for the TESA–Wisconsin Spring Convention June 24–25 was announced. It will be C. W. Harder, president of the National Federation of Independent Business Men.

Most important business for the eve-

ning was the nomination of officers. So far, they are:

President: F. Schroeder, L. Zechel and Lee Cowen

Vice president: Dan Smith

Secretary: Jack Huron, J. Guendert

Treasurer: J. Zaniewski

SRTT NEWS

Van Nuys, Calif.—Quite a group turned out to the regular Society of Radio & Television Technicians Inc. meeting. The subject "Tough Dogs" brought out the mangy pooches and some very interesting discussions involved. We were very happy to have as our special guest Bob Middleton. An interesting speaker as well as a writer, Bob plans to make his home in Southern California. Andrews Electronics, with the able direction of Bruce McColly, showed us RCA's new dot-bar generator. Capitol Electronics demonstrated Mercury's new substitution box and transistor diode checker.—*IPET*

NEDA SAYS "HANDS OFF" ON LICENSING CONTROVERSY

Chicago, Ill.—Hands off is the policy of the National Electronic Distributors Association toward supporting or opposing service technician licensing. NEDA executive vice president Gail Carter says that several legislative bodies have asked NEDA for its views on licensing, but NEDA will not take sides.

GLENDALE-BURBANK CSEA

Bob Chapman of Magnavox Corp. was guest of the evening at the regular meeting of the Glendale–Burbank Chapter of the California State Electronics Association. A complete report on licensing and the Professional Electronic Technicians Society Show in February rounded out a very full agenda.—*IPET*

ABOUT COMPLAINERS

In establishing prices, warranty policies and other business procedures, do not overlook the apparently very common human factor of wishing to "complain." This is not to be confused with the occasional actual or (at least in the mind of the customer) reasonable complaint or inquiry.

The factor in question is typified by the many calls with which we are all familiar where the immediate reaction to a billing is "terrible" or "robbery" or "three times what it should be" and which appears as regularly in the case of the $5 service call as it does in that of $7.50, and is as loud in response to a billing for $12.42 as it is at $69.47.

It is apparently the same type of person who complains that "the set never did work right" or "it's worse than it was before" or "this never happened before you worked on it." A tweezer and scalpel are the most useful tools for finding out roughly what, if any, the troubles actually are.

The latest case in point was a voice on the TSA telephone wanting to "put a black mark" on one of our shops. "He is a crook" and "ran up a fantastic bill." He realizes that we are a "useless outfit" like the BBB. Refuses to give his name, talk about the type of repair, the shop in question, or anything else that might possibly make sense. In other words, he wanted to complain. Period.

The point to be borne in mind is that while we most seriously consider and try to avoid or correct any remotely legitimate complaint, we also should try to recognize and make a proper distinction between this and the above situation.

It is the height of foolishness and unfair to ourselves, other shops and other customers, to turn our businesses upside down and make great concessions to try to placate these people who do not want to be pleased.—*TSA Service News*

TESA SUMMIT COUNTY

Akron, Ohio—New officers for 1961 of the Television & Electronic Service Association of Summit County were installed at a recent meeting. The elected officers are: Charles Papp, president; Arthur Clough, vice president; Julius Klusty, secretary, and Joseph Lutz, treasurer.

Elected as director to represent the group at NATESA and TESA of Ohio conventions was Jerry Barkoukis. Alternate director is Jack Reitz.

PASADENA CSEA

Arcadia, Calif.—The Pasadena Chapter of CSEA held a special dinner meeting at Rand's Restaurant. The guest of honor was Bruce V. Reagan, Assemblyman for the 47th District and a member of the Governmental Efficiency and Economy Committee considering licensing Bill AB 2829. Forty-four members and guests attended, and heard Ken Menzies, Bob Dumas, Ron Kealey, and Ben Leff explain the abuses and perils to the public under present unlicensed activities. Mr. Reagan held the closing spot with interesting comments of his own, and with advice on best ways of proceeding to CSEA's goal.—*IPET*

LICENSE TEST STATISTICS

Kansas City, Kans.—Of the first 208 service technicians and dealers to take the examination for city licenses, 190 passed and 18 failed. Those who failed were given 30 days to take another test. All technicians in Kansas City must be licensed. An applicant must pass the test, then pay $25 for a dealer license or $10 for a technician license.

NEW ASSOCIATION

Hibbing, Minn.—Word reaches us of another service association.

Range TV Service Association
Box 782
Hibbing, Minn.
Alfred Schmidt, Secretary

We are happy to add this association to our growing list.

A STORY WITH A PUNCH

The following editorial appeared in the TESA-Cleveland publication.

SXXING IS BXLIXVING

Wx must apologizx for this xditorial but thx typxwritxr wx arx using has a dxfxctivx lxttxr. Thx missing lxttxr is thx onx bxtwxxn "D" and "F" in

thx alphabxt. Wx havx had to improvisx in ordxr to gxt our mxssagx across. In kxxping with thx attitudx of so many indxpxndxnt sxrvicx dxalxrs in thx arxa, "What's onx missing charactxr morx or lxss, thxrx arx still 25 othxr lxttxrs to usx." "Lxt Gxorgx do it." No onx will xvxr miss onx littlx lxttxr, or xvxn miss onx littlx mxmbxr at an Association mxxting. "Our prxsxncx at mxxtings isn't vxry important, lxt thx othxr guys go and do all thx work, I'm just onx littlx guy, thxy don't nxxd mx, and I don't nxxd thxm."

Yxs, I guxss that many of thx "Hxxl Draggxrs" just do not sxxm to sxx thx light. Thxy do not rxalizx that wx arx trying to hxlp thxm. Xach littlx charactxr is vxry vital, as is xvxry lxttxr in thx alphabxt. Itxm or pxrson, all arx nxcxssary, and havx to work togxthxr to makx sxnsx or to makx progrxss. Isn't this a finx xxamplx?

Sincxrxly,
Gxorgx Srdjak, Sxcrxtary

Sxx you at our nxxt mxxting? END

50 Years Ago

In Gernsback Publications

HUGO GERNSBACK, *Founder*

Modern Electronics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In May, 1911, *Modern Electrics*

New Eiffel Tower Time Signals.

Solar Generator.

A Silicon Ticker, by Stanley Hyde.

Three-Slide Tuner, by William S. Wilder.

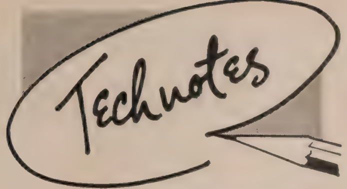
Tuning Coil of Fine Adjustment, by Harold Hermann.

Experimental Wireless Telephone

A Loose Coupler, by Walter Lean.

Wireless Across the U.S., by E. A. Mayne.

"It's a people clip."

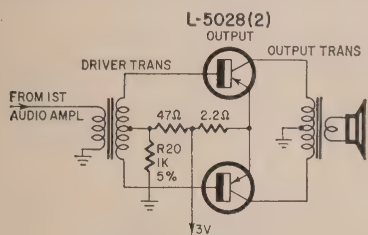


RADIO ALIGNMENT

Occasionally a radio does not completely cover the lower end of the broadcast band and does not have a pad adjustment. The usual solution is to shift the intermediate frequency with a reduction in gain, or replace the oscillator coil. A simpler solution to this problem is to insert a small iron coil slug in the air-core oscillator coil. This will lower the oscillator frequency, extending it to the low end of the band. The slug should be wrapped with a piece of plastic tape to prevent shorting the coil terminals which extend into the coil's core. When the proper position of the slug has been determined, a small amount of service cement will keep it in place.—*Albert J. Krukowski*

PHILCO T7 RADIOS

Every so often you'll run into one of these sets suffering from distortion on low-volume signals. Usually the trouble is at resistor R20. Simply unsolder the grounded end of this



1,000-ohm unit. Then clean the ground point and resolder.

Before unsoldering, you might check for a small voltage reading between the resistor lead going to ground and ground. Any reading at all confirms a poor ground connection.—*A. von Zook*

CHECK CURRENT DRAIN

When I finish repairing a transistor radio, I always measure the total current drawn from the battery and make a note of it on the set's schematic. To insure a consistent reading, I make the measurement with the volume control turned down. This is a great aid when a similar model comes in for repairs. By comparing current readings, I can determine what type of trouble to look for.

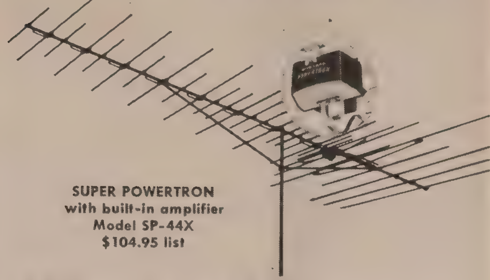
For example, a shorted transistor or coupling capacitor will cause a large increase in current drain, and an open transistor or if coil will cause a decrease in current drain. —*Albert J. Krukowski*

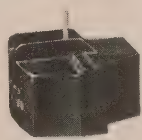
HEATH OM-1 SCOPE

In several cases this scope has shown considerable vertical deflection with the attenuator in minimum position and with no signal applied. Examination shows this to be 60-cycle sine-wave deflection.

WE BUY TECHNOTES

Attention all service technicians! RADIO-ELECTRONICS will pay you $5 for each acceptable item you send us for the Technote column. Acceptable circuit diagrams used to illustrate the item raise the basic price to $9. Acceptable photos are worth $7 each. We especially want Technotes on specific models (see the RCA 8BT-10K and Philco T7 here). So write up that tricky or interesting service job and rush it to: Technotes Editor, RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N. Y.



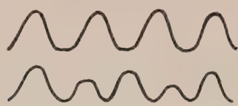


This is caused by the introduction of a 60-cycle voltage on the cathode of the second stage of the vertical amplifier. The voltage develops because of a common path in the etched circuit consisting of the heater and cathode return to the chassis. The etched circuit has enough resistance to cause a voltage drop when the heater current flows through it. This voltage drop is in series with the cathode and appears as vertical deflection on the scope.

The remedy is to ground one end of a piece of hookup wire under one of the circuit-board mounting bolts and solder the other end directly to the heater pin on the socket. This provides a low-resistance path to the chassis for the heater and cures the stray deflection.—*Walter E. Weffenstette*

SCOPE CHECKS RECTIFIER

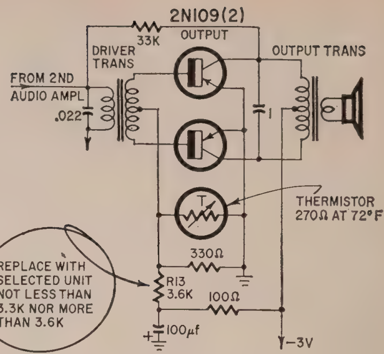
If a full-wave power supply shows an increased hum level, a good check is to connect a scope to the cathode of the rectifier tube. You will normally see a peaked 120-cycle waveform. However, if the rectifier tube is approaching the



end of its life, you may observe that every second peak is higher. This is an indication that the two sections of the rectifier are unbalanced. Such a condition introduces a spurious 60-cycle component into the output. This is harder to filter than the normal 120-cycle wave and thus increases the hum level. When such a condition is observed, replace the rectifier tube, regardless of how it looks in a tube tester. —*Charles Erwin Cohn*

RCA 8BT-10K

Audio distortion was ruining reception on this receiver, and our customer wanted it reduced to a reasonable level. Checking the circuit showed that R13, a 3,600-ohm 10% resistor off the center tap of the driver transformer, had gone



up in value. Replacing it with another 3,600-ohm unit reduced the distortion. In cases like this, according to RCA service data, the replacement resistor should be a selected unit that has a value no less than 3,300 or more than 3,600 ohms.—*M. L. Leonard*

HIGH-VOLTAGE ARCING

With the summer months, and with them some high-humidity weather coming along, arcing tends to become a common TV trouble. The usual place this breakdown appears, because of a combination of dust and moisture, is at the anode button on the TV picture tube. Cleaning the button and about a 2-inch circle around it can eliminate this problem. A mixture of water and ordinary household detergent will do. After cleaning, connect the high-voltage lead and lay a 6-inch square of Saran wrap over the area.

Be sure that the set is turned off and the anode lead and button discharged to the chassis before starting the cleaning job. Dry the area with a paper towel before connecting the set again.—*Larry Steckler* END

NOTEWORTHY CIRCUITS

CHRONISTOR

Many devices are used as elapsed-time indicators. Probably the commonest is the ordinary electric clock. Perhaps the most esoteric is a little device that exposes a piece of paper to light. The paper darkens slowly and elapsed time is read by comparing its color with a color chart.

Now there is a simple device that accurately *measures* time. It is the size of a cartridge fuse and comparatively inexpensive. This is the Chronistor made by Bergen Laboratories, Paterson, N.J.

The unit works on an electroplating principle and can be used to indicate the total number of hours during which any electrical device has been in operation. It requires only a tiny amount of current which is supplied by the unit being timed.

The Chronistor is essentially a miniature electroplating bath containing an anode, cathode and electrolyte (Fig. 1). When dc passes through the electrolyte, metal ions are carried from the anode to the cathode. Obviously the length of the cathode and the anode will change as current is fed through the unit—the anode will get shorter while the cathode gets longer. This lengthening takes place at a constant rate and shows up against a time scale placed alongside the anode. This scale is calibrated in hours (Fig. 2).

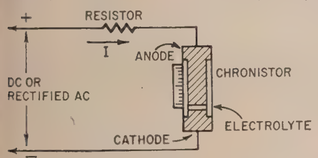


Fig.1

Note the resistor in series with the Chronistor in Fig. 1. It limits current flow through the unit to 0.34 ma, since the resistance of the Chronistor is only about 200 ohms. This series resistor also helps maintain a constant current flow through the Chronistor.

An ideal use for these units would be a 1,000-hour 117-volt Chronistor connected to indicate the time a diamond phonograph needle has been in use. Such a timer would let the user know when he should replace the needle in

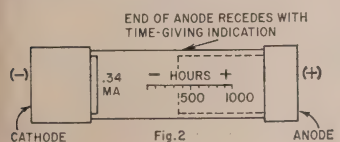


Fig.2

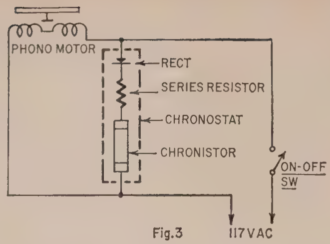


Fig.3

his set, thus avoiding damage to his record collection. For this application a Chronostat timer is available. It consists of a 1,000-hour Chronistor with a built-in rectifier and a series resistor. The unit is connected across the phonograph (Fig. 3) motor and thus indicates elapsed time only when the phonograph is being used.

HEAVY DUTY AC-DC RELAY

Many applications about the home or lab require the use of a heavy-duty relay able to actuate circuits drawing hundreds of watts of power from the line. These are readily available from leading electronics warehouses, but they all come in either ac- or dc-operated form. Here is a simple-to-construct heavy-duty relay that will operate on either ac or dc and will handle up to 1,500 watts, depending on the type of snap-action switch employed.

Plan to mount all the parts on a flat square metal base measuring about 3⅝ x 1-15/16 inches, and at least 1/16 inch thick. Exact dimensions depend on the physical size of the snap-action switch as well as the actuating coil. Choose a switch having a leaf-spring-hinged action, such as the Unimax 2HBT1, and mount it firmly in the center near one end of the metal base (Fig. 1). Use washers or a nut to elevate the switch about 3/16 inch above the base plate. Construct a stop which will serve as a sensitivity adjustment by resting a bolt against the leaf spring. Use one or two nuts to lock the adjustment once it is made.

The actuating coil can be one salvaged from a telephone type relay, TX-3A (surplus market), or a spool can be made with a pair of fiber or plastic discs and a ¼-inch soft-iron rod or bolt. The spool should be 15/16 inch long; the face of the spool is 12/16 inch in diameter. Fill the spool with as many turns as possible of No. 30 or 31 enamel-covered wire, and be sure to insulate the rod or bolt with one layer of cellophane tape or other soldered connections. Mount the coil near the switch with one end in line with the leaf spring. Adjust the position of the coil so that the switch is actuated just as the leaf spring touches the coil end. Later, finer adjustment can be made with the stop.

For both ac and dc operation, you will have to include in the circuit a low-cost power type transistor like the Olson X846 or Lafayette SP-147 strapped as a diode rectifier, and a 100-μf electrolytic. These are connected as shown in Fig. 2. Upon completing and testing the unit, house it in a suitable metal case and mount the transistor on the top. This will help dissipate some of the heat generated in

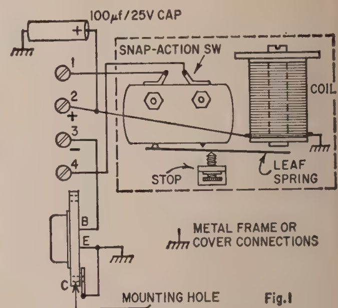


Fig.1

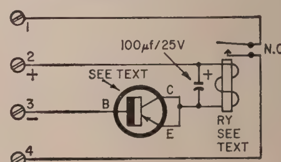


Fig.2

the transistor when the relay is used on ac. When soldering connections to the transistor, hold the terminals in heavy pliers to carry away the heat. For dc operation, you will have to observe the proper polarity.—*Martin H. Patrick*

END

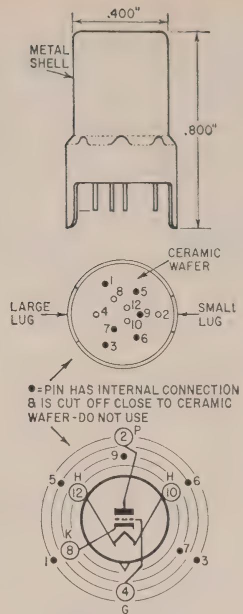
NEW TUBES and SEMI-CONDUCTORS

ANOTHER nuvistor triode leads off this month. It is backed up by a couple of ultra-fast switching transistors, a series of horizontal output tubes for TV, and a power rectifier with double filament and plate leads.

7895

This triode is another addition to the growing line of subminiature metal-cased nuvistors. It has an amplification factor of 64 and is intended for a variety of industrial applications. It can deliver high gain with low noise in such amplifier circuits as cascode, rf and if, on–off control and resistance-coupled. It also offers good stability as an oscillator from very low audio frequencies up into the uhf region.

Note the unusual basing of this tube.



INDEX= LARGE LUG

7895

Instead of the normal arrangement of pins in a single circle, there are four concentric circles of pins. This is necessary because of the construction of the nuvistor (see diagram). The nuvistor is built up of concentric elements. Each element (except for the heater) has three supporting pins. Two are cut flush with the base wafer and are unused. The remaining one becomes the active pin for that element.

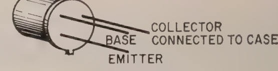
For example, looking at the basing diagram you will see that the innermost circle has two pins for the heater, both used. However, each of the other three circles has 3 pins spaced 120° apart. One pin in each circle is used, while the other two are merely supports for the internal structure of the tube.

Characteristics of the RCA nuvistor 7895 as a class-A1 amplifier are:

V_{htr}	6.3
I_{htr} (ma)	135
$V_{P\ supply}$	110
$V_{G\ supply}$	0
R_K (ohms)	150
μ	64
R_P (ohms)	6,800
gm (μmhos)	9,400
I_P (ma)	7
V_G (for 10 μa I_P)	−4

2N743, 2N744

Ultra-fast silicon n-p-n switching transistors made by the epitaxial manufacturing process, these two new units are claimed to be at least twice as fast



2N743, 2N744

as any other commercially available silicon switching transistor.

Comparing the 2N743 with a conventional silicon switching transistor (2N706) in equivalent circuitry, the 2N743 switches in one-half the time at current levels of 10 ma and one-quarter the time at 100 ma.

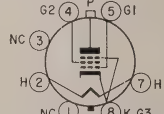
Maximum ratings of these Texas Instruments transistors are:

V_{CE}	12
V_{CB}	20
V_{EB}	5
I_C (continous) (ma)	200
P_{total} (mw)	300

6GW6, 12GW6, 17GW6

A series of beam power tubes in glass-octal envelopes designed for use as horizontal deflection amplifiers in high-efficiency TV deflection circuits. The following characteristics make it possible for these tubes to provide full deflection for systems using wide-angle or high-ultor-voltage picture tubes:

▸ Excellent knee-current characteristics—the 'GW6's can deliver a 390-ma plate current with zero bias and only 60 volts on the plate.



6GW6, 12GW6, 17GW6

▶ High ratio of plate current to grid-2 current.

▶ High voltage and dissipation ratings.

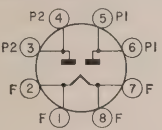
All three tubes have identical electrical characteristics except for heater ratings. The 6GW6 has a 6.3-volt 1.2-amp heater; the 12GW6 a 12.6-volt 600-ma controlled-warmup heater, and the 17GW6 a 16.8-volt 450-ma controlled-warmup heater.

Maximum ratings of these RCA tubes in horizontal deflection amplifier service:

$V_{P\ supply}$ (boost plus dc pwr)	770
Peak positive pulse	6,500
Peak negative pulse	1,500
V_{G2}	220
V_{GL}	−55
V_{G1} (peak negative pulse)	330
I_K (peak) (ma)	550
(average) (ma)	175
V_{G2} (input) (watts)	3.5
P_P (watts)	17.5

5DJ4

A high-vacuum power rectifier with double filament leads and double plate



5DJ4

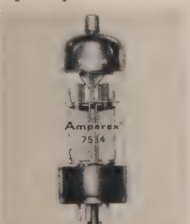
leads which reduce the current through each lead to one-half the current of single-lead tubes. Electrically, the 5DJ4 is identical to the 5U4-GB and may be used for the same applications.

Typical operating conditions and characteristics of the Tung-Sol 5DJ6 as a full-wave rectifier with capacitor input filter are:

$V_{P\ supply}$ (rms) (each plate)	300	450
$R_{Plate\ supply}$ (each plate) (ohms)	21	67
Input filter capacitor (μf)	40	40
I_{output} (dc) (ma)	300	275
V_{output} (dc)	290	460

7534

A premium power pentode that incorporates two frame grids, one a control grid, and the other a screen grid. It is an output pentode designed for use as a wide-band amplifier, cathode follower, series stabilizer in electronic power supplies and as an output tube in class-B push-pull circuits.



The Amperex 7534 has a transconductance of 25,000 μmhos. Cathode current is 300 ma, making the tube suitable for use as a TV deflection amplifier.

In power amplifier circuits—push-pull class-B—the tube can deliver up to 60 watts. Total harmonic distortion is 5%. and with feedback can be reduced to less than 1%. END

new PATENTS

IMPROVED COMPRESSION SPEAKER

Patent No. 2,907,837

Joseph Brami, New York, N. Y.

The patent discloses a compression loudspeaker (Fig. 1) in which the diaphragm is driven by a dual-winding voice coil. The winding connected to terminals A-A is fed with the sound signal (curve A, Fig. 2) and the other winding (terminals B–B) is fed with a rectified current (curve B, Fig. 2) derived from the sound signal. The rectified current is fed in such a direction that the diaphragm, while vibrating, moves backward from the chamber wall as a function of its amplitudes. As a result (curve C, Fig. 2) the diaphragm vibrated "unilaterally" from its no-signal resting position. This prevents its bumpings against the chamber wall and permits its compressions to be complete for all amplitudes. A flexible suspension allows the diaphragm unlimited excursions, so that the entire sound-frequency range is reproduced with high fidelity and a considerable amount of sound power is delivered. The patent seeks to solve the problem of the high-fidelity speaker with a single diaphragm, and also that of the long-range sound projector.

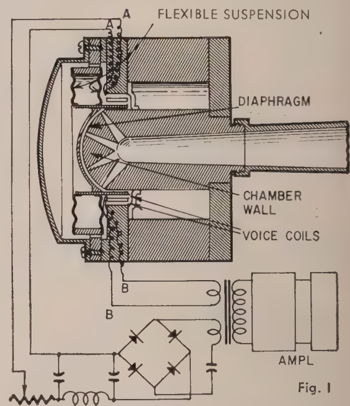


Fig. 1

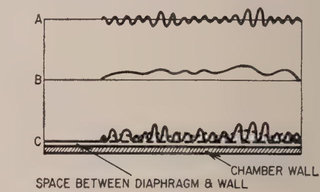


Fig.2

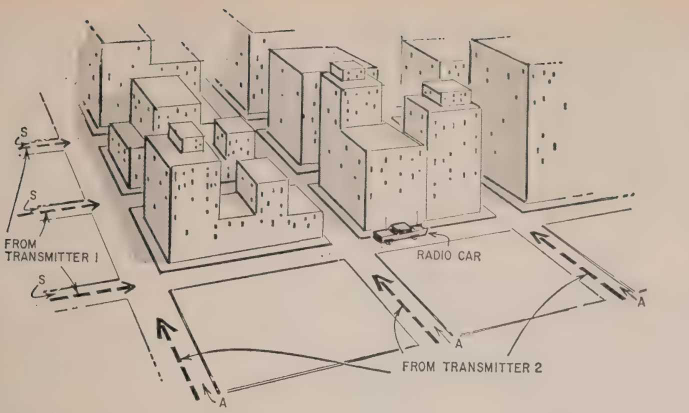
URBAN MOBILE RADIO

Patent No. 2,941,201

Wallace C. Babcock, Chatham, N. J. (Assigned to Bell Telephone Labs, Inc.)

Police and other mobile radio systems are seriously handicapped in large cities because tall buildings throw deep radio shadows. Here is a method for overcoming this problem. It is based on the fact that streets generally run at right angles to each other.

The diagram shows several blocks of a city, streets (S) running at right angles to avenues (a). The plan is to locate 2 transmitters several miles from the city, with antennas on high towers. The stations transmit the same signal.



One sends in a direction along the avenues, the other along the streets. The radio car or mobile station uses a directional antenna composed of two quarter-wave whips mounted fore and aft on the vehicle. The antenna has a sharp "figure 8" response pattern with its major axis along the car's longitudinal axis. Regardless of whether a mobile unit is riding along a street or an avenue, it always picks up a strong signal.

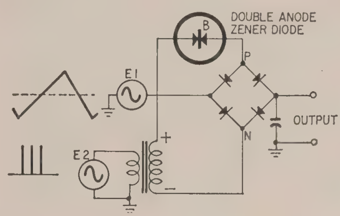
DIODE BRIDGE GATE

Patent No. 2,965,771

Leonard Finkel, Haddonfield, N. J. (Assigned to American Bosch Arma Corp., Hempstead, N. Y.)

This gate opens and closes periodically. When it conducts, E1 is connected directly to the output terminals; otherwise it is isolated. The circuit may be used to sample a signal. The gating pulses, E2, are stepped up by a transformer and fed across the four-diode bridge (with polarity shown).

The diagram shows four diodes. Note, also, the back-to-back Zener. If the gating pulse is large enough, it breaks down the nonconducting section of the Zener, making P more positive than N. This biases each arm of the bridge to conduction and a low impedance exists between E1 and the output terminals.



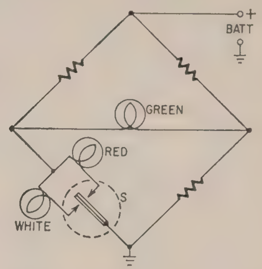
When there are no timing pulses, E1 cannot get through. It is blocked by the diodes in the bridge.

TRIPLE CONDITION INDICATOR

Patent No. 2,962,703

Ray E. Summerer, Grand Blanc, Mich. (Assigned to General Motors Corp., Detroit)

These colored pilot lamps indicate three operating conditions. The bridge contains three resistive arms, the fourth being one of the lamps. The bridge balances when either the red or the white lamp is switched into the lower left arm.



A three-position bimetal switch (S) is exposed to heat, for example from an engine coolant. When the temperature is normal, the switch is in neutral (as shown). If there is too much heat, it closes the right contact and, if too little, the left contact is closed.

With normal heat (see diagram), the switch is open and the bridge unbalanced. The green light goes on. At high temperature the red light is on, and at low temperature the white one shines. In both of these cases the bridge balances so the green light is off. END

TRY THIS ONE

BENCH CLEANING KINK

Electronic technicians and experimenters usually get their workbenches pretty well messed up during the course of their work. For cleanup purposes a swipe across the bench with a rag doesn't quite do the job. Small pieces of wire and insulation get caught in the rag. And the excess solder flicked from the soldering iron usually sticks to the bench top. A piece of straight-edged bakelite or Masonite makes a nice cleanup tool. Just scrape it across the bench top. It will gather wire and insulation scraps. And it will quickly loosen and gather solder stuck to the bench top. It works well on floors too. This beats loosening stuck pieces of solder one at a time with a screwdriver or with your fingernails.—*Forrest H. Frantz, Sr.*

QUICK CAPACITOR CONNECTIONS

When a can type electrolytic capacitor is used in experimental or breadboard layouts, quicker connections can be made if Fahnestock clips are soldered to the electrolytic's lugs as shown. Since the capacitor's metal case is invariably the negative terminal, solder a clip to it too. With this handy ar-

rangement, the capacitor can be wired in and out of the circuit in a jiffy. By connecting test leads to the capacitor's clips it can be easily used to find bad filter capacitors in radios, TV's and other gear by the substitution method. —*Joe Crane*

FUSED CHEATER CORD

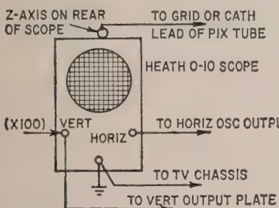
The cheater cords used by our outside men all have a fuse holder and 5-amp auto fuse in series with one leg. This prevents blowing the customer's fuse and the subsequent time-wasting hunt to replace it.—*Stan Clark*

TV PIX ON SCOPE

Here's a method I use for substituting an oscilloscope for the picture tube in a TV set. I have been getting excellent results with this method and find that many times it has taken the guesswork out of servicing.

This is how I hook up my Heath O-10 scope to a typical TV set:

- Vertical input (×100) to plate of vertical output tube.
- Horizontal input to output of horizontal oscillator (grid lead to horizontal output).



- Z-axis input of scope to grid or cathode of picture tube depending on whether circuit uses grid- or cathode-modulated tube.
- Ground scope to TV, set horizontal frequency control to external input and there you are.

One word of warning: the scope's intensity control must be turned down before turning off the TV or the high intensity of the undeflected beam might burn the screen.—*Charles M. Breidenstein*

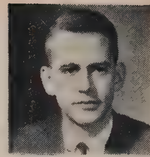
EXTRA-THIN NUTS

When an extra-thin nut is required in some cramped part of a chassis, cut a small square of sheet metal, punch a hole through it and tap the hole with threads to fit the matching screw. Punching instead of drilling bends the metal outward around the hole, adding metal for a longer thread.—*Harry J. Miller* END

BUSINESS and PEOPLE

Adolph Wolf was appointed vice president of Manufacturing for Electro-Voice, Inc., Buchanan, Mich. He comes to the company from Zenith Radio where he was assistant general production engineer. **Jon Kelly** and **Rod Griggs** joined the regular sales staff as trainees. Kelly formerly handled technical correspondence for high-fidelity and commercial sound products and Griggs was a correspondent in the Marine Div. for communication equipment.

Jan Bleeksma was appointed vice president in charge of manufacturing at Amperex Electronic Corp., Hicksville, N. Y. He had been plant manager.



Donald H. Bittner was promoted to Eastern regional distributor sales manager for Shure Brothers, Inc., Evanston, Ill. He has been with the company since 1956.

M. S. Sumberg was promoted to the newly created position of director of sales, sound products and high fidelity, for the Bogen-Presto Div. of the Siegler Corp., Paramus, N. J. He has been with the company since 1949 in a variety of executive marketing positions. **Harold Barton** (left) joined the company as sales manager for high-fidelity equipment from United Audio Products.

James W. Kearns, administrative assistant to the president, was promoted to field sales specialist. **David E. Pear**, **Arthur Callahan** and **Harris Anderman** continue as managers of Advertising

and Sales Promotion, Public Address and Intercom, and School and Industrial Systems respectively.

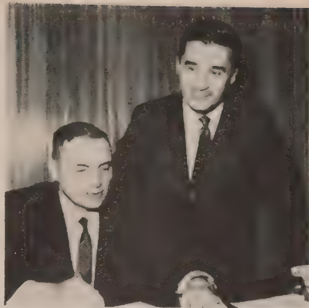
John Kushan was promoted to director of materials of Hickok Electrical Instrument Co., Cleveland, Ohio, from production control manager.

Wesley E. Wood joined Astron Sales Corp., Newark, N. J., as distributor sales manager. He comes from Allen B. Dumont Labs., Div. of Fairchild Camera and Instrument Corp., where he was distributor sales manager of the Electronic Tube Div.

Milton S. Kiver, editor and author in the field of electronics, established a new firm, Milton S. Kiver Publications, Chicago, which will publish a new magazine in the field, and also act as a consultant in the development of new products and techniques.

James W. Blanchard was promoted to assistant credit manager of CBS Electronics, Danvers, Mass. He had been a credit analyst for the company.

Harman-Kardon, Inc., Plainview, N. Y., was merged into Jerrold Electronics Corp., Philadelphia. The merged companies plan an accelerated expansion program. Milton J. Shapp, president of Jerrold, (left) and Sidney Harman, president of Harman-Kardon are shown signing the closing papers.



Martin A. Lappin was named national manager for the newly formed TV-Communications Dept., of Westinghouse Electric Corp., Metuchen, N. J. He was formerly vice president of American Communications Corp.

Myron A. Brauner joined Amphenol-Borg Electronics Corp., Broadview, Ill., as district sales manager in the Metropolitan New York territory. He has established temporary headquarters in the company's Great Neck, N. Y., offices. He previously had been with Markite Corp. END

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INVENTIONS WANTED

(Continued from P. 31)

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1382. IDENTIFICATION DEVICE.—A lightweight device to be carried by small Army aircraft, helicopters and zero-ground-pressure vehicles to permit positive and extremely rapid identification of the vehicles by friendly forward-area anti-aircraft weapons operating primarily against low-flying enemy aircraft. This device should be capable of being carried by ground vehicles for air-to-ground and ground-to-ground identification of these friendly vehicles.

1407. TIMING DEVICE.—Develop an accurate (±1%), short-period (5 minutes or less), rugged, inexpensive, highly reliable timing device having long shelf-life capability.

1425. HIGH-TEMPERATURE FEEDBACK POTENTIOMETER.—Design a feedback potentiometer for use in the high-temperature (1,000°F) environments associated with missile servos.

1453. ELECTROMAGNETIC RADIATION WARNING DEVICE.—Develop a simple, reliable, inexpensive, lightweight instrument which will warn the carrier when he is in an area of electromagnetic energy of a power level of .010 watt/cm² or greater. The warning should be of the audible, subaudible (vibratory) or thermal type, depending on the environment in which the instrument is to be used.

1462. A METHOD FOR OBSERVING THE INSIDE OF BURNING ROCKET MOTORS.—A technique for the observation of the internal burning process in a solid rocket would be an extremely valuable research tool. The technique need not give rise to a pictorial presentation. Any means by which internal burning processes could be better characterized would be quite useful. To this end, radioactive isotopes should receive strong consideration.

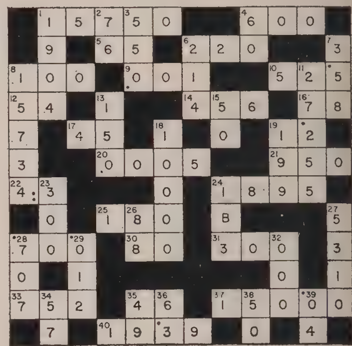
NEW DEFINITIONS

A list of 21 new (and possibly official) electronic definitions was released by Raytheon. They are:

Damped oscillation—end of a rock 'n roll party
Inertial guidance—permissive parenthood, or leaving well enough alone
Countermeasures—Dr. Spock's system, the opposite of inertial guidance
Thermistor—a hot engineer
Semiconductor—railway official under 5 foot 2
Telemetering—why women need unlimited phone service
Esaki diode—verses read at a Tokyo wake
Triode—what the beat poet writes
Condenser—designer of midget radios

END

Answer to Electronics Numbers Puzzle on Page 68



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new BOOKS

ELECTRONIC EQUIPMENT RELIABILITY, by G. W. A. Dummer and N. Griffin. John Wiley & Sons Inc., New York, N. Y. 5½ x 8½ in. 274 pp. $7.50.

The complexity of electronic circuits continues to grow rapidly, and the chance of breakdown increases still faster. An expensive device like a computer or a satellite can be put out of operation by failure of a single component out of many thousands.

The authors analyze the causes of failure in components, tubes and circuits. Numerous charts show the effects of temperature, vibration, radiation, design, storage and other factors. A number of preferred circuits are described and recommended for maximum reliability and simpler maintenance. Solderless connections, printed wiring, derating, testing, miniaturization and sealing are among the topics. Later chapters tell how to design and test for maximum reliability.—*IQ*

FROM MICROPHONE TO EAR (2nd Edition), by G. Slot. MacMillan Co., 60 Fifth Ave., New York 11, N. Y. 5½ x 8 in. 258 pp. $4.50.

This practical book describes components, techniques and care of sound equipment. Tape and disc are completely covered for the benefit of technicians and music-lovers. The book contains much useful information on the characteristics of pickups, record changers and speakers. The care of styli and records receive special attention, as do stereo and tape recording.—*IQ*

SUCCESSFUL PREPARATION FOR FCC RADIO OPERATOR LICENSE EXAMINATIONS, by Darrell L. Geiger. Prentice-Hall, Inc., Englewood Cliffs, N. J. 6 x 9 in. 689 pp. $8.95.

This book covers all elements needed to pass a commercial radio operator's license examination. It lists all questions (and their answers) likely to be asked by the FCC. All answers are explicit and complete, with diagrams appearing where applicable.

As pointed out by the author, the student is presumed to have a good basic knowledge of theory and code before taking the exam. Suggested textbooks are listed, as well as Q signals and abbreviations. License requirements, study hints and where to take the exam are also covered.—*IQ*

REPAIRING TRANSISTOR RADIOS, by S. Libes. John F. Rider Publisher Inc., 116 West 14th St., New York 11, N. Y. 5½ x 8½ in. 159 pp. $3.50.

This practical book is especially suitable for beginners. It analyzes the separate circuits of a transistor radio, shows how to adjust and repair them, lists quick tests and servicing charts. Portable and auto sets are emphasized. Several representative schematics

SCHOOL DIRECTORY

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appear in the book, and are analyzed by the author. He also includes chapters on troubleshooting and test equipment.—*IQ*

ELECTRONIC COMPUTERS (2nd edition), by T. E. Ivall. Philosophical Library, 15 E. 40 St., New York, N. Y. 5½ x 8½ in. 263 pp. $15.

This new edition brings its subject matter up to date. The text is largely nonmathematical and is suitable for readers who know radio techniques. Both digital and analog computers are discussed, and typical equipment is described and illustrated.

Circuitry, construction and application of all types are well covered. The book ends with more recent developments and the possibilities of designing a "thinking" machine in the future. Students, technicians and engineers will find this text helpful as an introduction and as a guide.—*IQ*

BASICS OF ANALOG COMPUTERS, by T. D. Truitt and A. E. Rogers. John F. Rider Publisher Inc., 116 W. 14 St., New York 11, N. Y. 6½ x 9 in. 378 pp. $12.50.

This is a picture text course on the modern computer. Many types are described but emphasis is on the dc analog computer. Basic theory and equations are developed at a pace easy for college students, engineers, maintenance technicians and others. Illustrations and diagrams clarify principles and applications. Review questions are included.—*IQ*

1960 NORTHEAST ELECTRONICS RESEARCH and ENGINEERING MEETING RECORD. Published by Lewis Winner. Available from Boston Section IRE, 313 Washington St., Newton 58, Mass. 8¼ x 11 in. 190 pp. $7.50.

This record contains digests of technical papers delivered at 40 technical sessions of the 1960 Northeast Electronics Research and Engineering Meeting held in Boston, Mass., in November. A wide variety of topics are discussed and illustrated. They include transistors, antennas, microwaves, circuits, space electronics, standards and measurements.—*IQ* END

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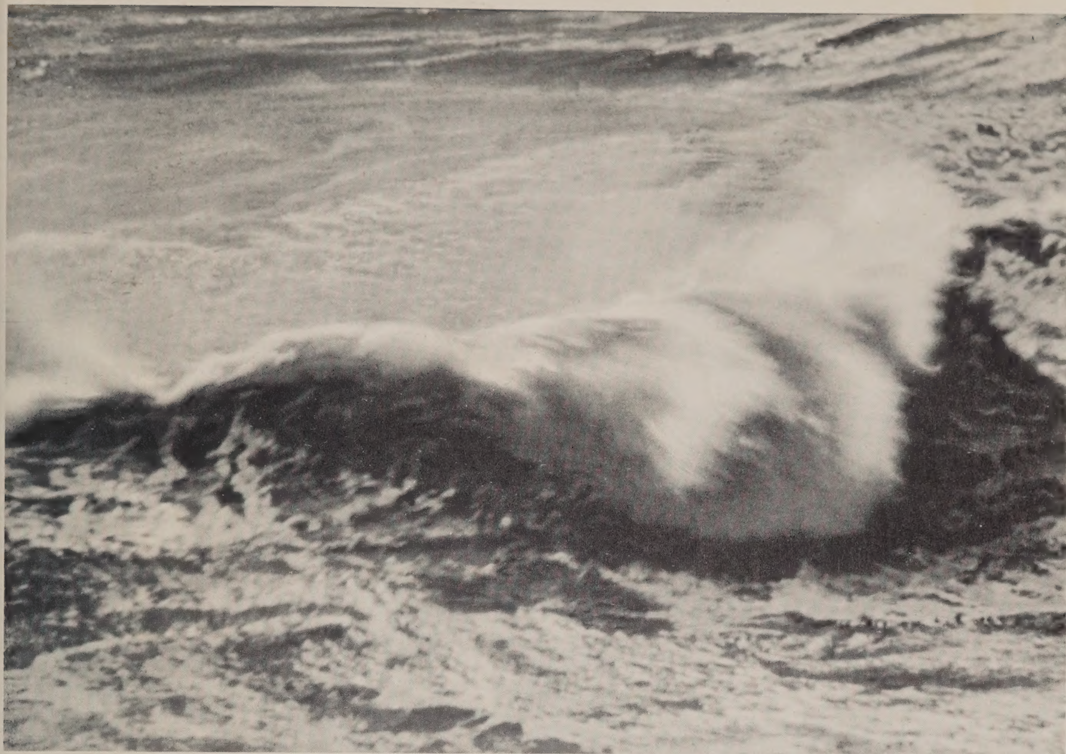

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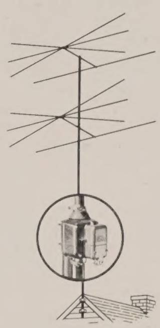

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